NEWS IN PERSPECTIVE

MANAGEMENT VIEW

BY THE YEAR 2000, studies made by EEI indicate, total annual output of the electric industry will be between 6 and 10-trillion kilowatt-hours. EEI's Pres. King comments: "What the figure actually will turn out to be will depend on the rate of growth of the national economy and the rate at which energy uses are introduced." (And, who has a crystal ball with a clear 40-year view?)

UTILITY FINANCING IN N. Y.—To secure $800-million of new money required to finance its five-year, $225-million construction program, ConEdison took this first step: petitioned the Public Service Commission to issue 600,000 shares of 5.75-percent series A cumulative preferred stock. And, Long Island Lighting set up an arrangement for 1960 needs with five banks in NYC for a revolving bank credit of $32.5-million and for additional credits not to exceed a total of $5.5-million with 14 banks on Long Island.

ATOM-AGE PR—ConEdison gave NYC's top labor leaders a look at its Indian Point nuclear powerplant project, including the precautions for protecting employees from hazardous levels of radiation (which will never be experienced by more than 20 employees in the 275,000-kw plant, says ConEdison officials). After the tour NYC Labor Council Pres. Van Arsdale observed: "This indicates that labor and management can develop broad understanding of each others problems."

And, in Pennsylvania, the Saxton Nuclear Experimental Corp. (organized by four subsidiaries of General Public Utilities Corp.) invited Penn State University to become (without cost) a participating member of the corporation . . . " in keeping with our objective of advancing the art of generating electric power by nuclear means," as the Corporation's Chairman Louis H. Roddis, Jr. put it. (Use of the proposed pressurized reactor for research and instruction was offered.)

ORDER FURTHER AHEAD?—This might well be considered on known equipment requirements, proposes a prominent utility buyer. Addressing the NAPA Utility Buyers' Group annual conference on Feb. 1, Alabama Power's George Cole noted he had "resisted" such a practice in the past, when manufacturers promoted the desirability of advance ordering to achieve better uniformity in their production schedules and resulting economies. "But now, with prices and escalation on a more realistic basis," said Mr. Cole, "Our organizations might reasonably consider going along with this program . . . with hopes that economies established will reflect in prices to us."

DIRECT CONVERSION OF ENERGY—EEI has undertaken a study of various methods looking to an evaluation of the potential of each that may serve the Institute as a basis for a possible future program or plan of action in this field. Working under the direction of a steering group that includes members of the EEI Prime Movers and Electrical System and Equipment committees, Prof. Theodore Baumeister of Columbia U. is conducting the evaluation. Organizations working in direct conversion development have been invited to submit information on their projects.

POLITICAL EDUCATION—Utility employees are getting more of it from company programs, though many in industry are cautious about the role an employer should assume in this controversial field. (See page 59.) Any utility, though, can (like Rochester Gas & Electric) gain from distributing material that encourages participation—for example, a handy little booklet entitled: "How to Address Your Senators and Representatives."

ECONOMIC CLIMATE

BUSINESS IS SURGING, nourished by the record flow of purchasing power. Personal income continues very high, and capital spending appears to be in a slightly rising trend. Annual rate of new investment in the final quarter was nearly $28-billion, and the year's total fell only a little shy of the peak touched in 1957. Consumer purchases continue at a high rate, with autos overcoming the slight lag as dealers acquire full, well-rounded inventories.

DIP IN SAVINGS RATE, particularly noticeable last year, appears to be continuing. Though the percentage of saving has dropped, higher incomes enabled people to add to their net worth at about the same absolute rate as in the preceding three years. Figures show, however, that virtually all of the $40-billion that has been added to disposable income since 1956 has gone into consumer markets.

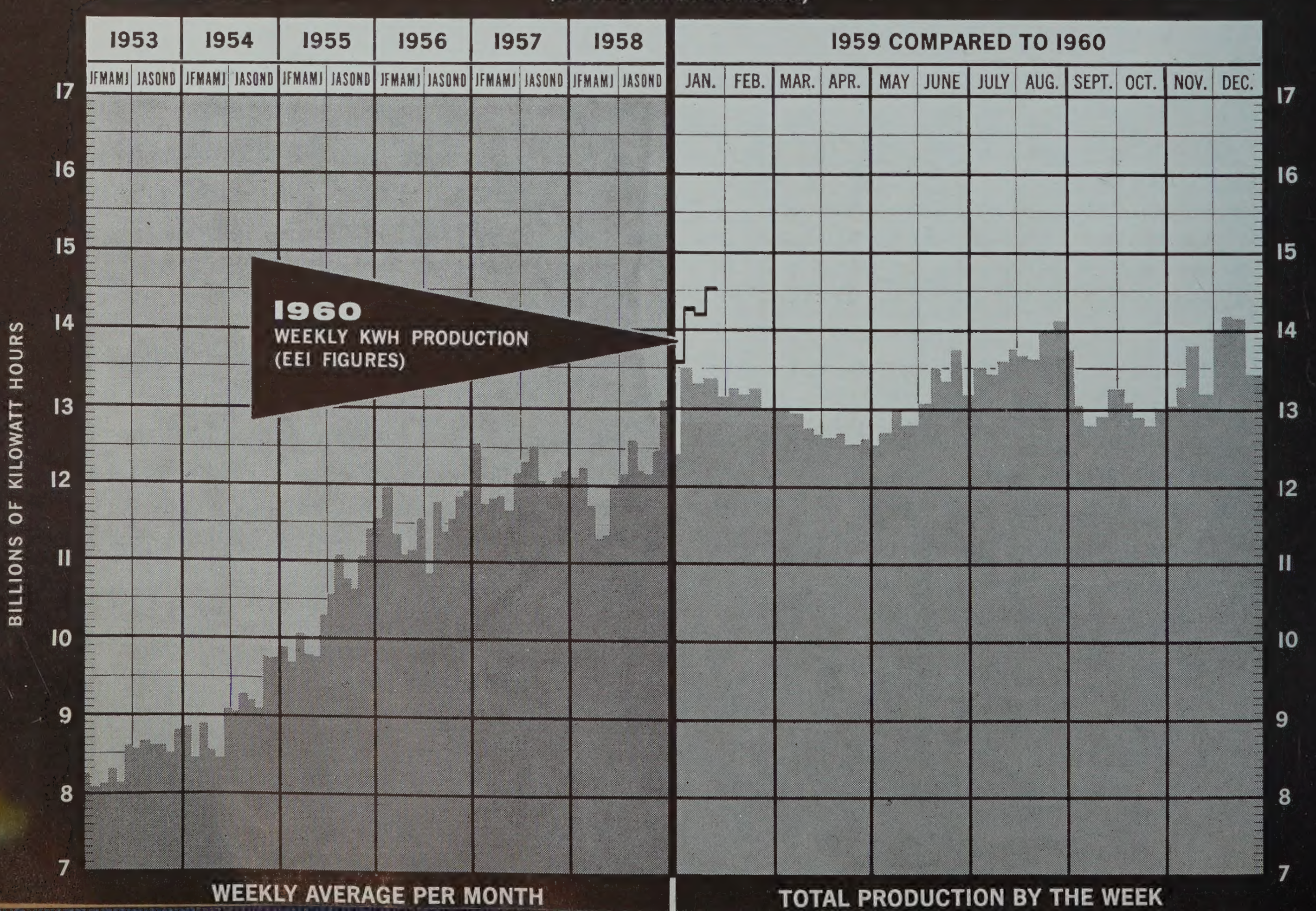
A MINORITY VIEW of the business outlook—perhaps better noted than heeded—sees no guarantee of a persistant rise to new economic heights this year. According to doubters, the impetus of inventory rebuilding (particularly in steel) will be spent by mid-year. If auto production outpaces demand, production will be cut in a month or so, which would act as a mild depressant on the whole of the economy. At the minimum, this would cut into the gains in the business rate generally expected for 1960.

WASHINGTON INFLUENCE

FLEXIBLE NATIONAL ENERGY POLICY has been called "an absolute need" by FPC Commissioner Connole. Its absence creates problems and inhibits sensible discussion of existing ones—such as the use of gas as a dump fuel and increasing interdependence of the U. S. and Canada. Connole decried special interest groups, applauded Administration-sponsored national fuels research proposal, but op-

Electric Utility Barometer

(Source: Edison Electric Institute)



posed the use of private groups. A national policy should have as a "bedrock foundation" a belief in low cost. It should consider pros and cons of importing natural gas from Canada and natural gas in liquid form from the Middle East and Venezuela as well as the ultimate value of subsidies for atomic energy.

REVERSAL OF DIXON-YATES decision has been asked by the Justice Department. It wants the Supreme Court to review a Claims Court decision awarding the utility $1.8-million in damages from the Federal government on the grounds the lower court set a "too-limited conflict-of-interest rule."

BLAST AGAINST AEC PROGRAM was delivered by Rep. Holifield (D., Calif.) to the Electric Consumer Information Committee. "Bookkeepers and budgeteers" instead of technical authorities are making the decisions, he claimed. He also disagreed with the AEC's decision to develop only two or three basic reactor concepts and to work on only small and moderate size plants. Holifield says JCAE will consider filling in the present program with development of a steam-cooled reactor, another type of steam reactor, plans for heavy-water reactors using natural uranium, and authorizing conversion of Hanford to a dual-purpose plant.

RESOURCES BILL, sponsored by Sen. Murray (D., Mont.), will probably come up for action this session. Murray, chairman of the Senate Interior Committee, expects to have it out of committee in plenty of time. The much-discussed "U. S. lag" behind USSR is expected to give impetus to passage.

BONNEVILLE STUDY OF INTERTIE between Pacific Northwest and California, sent to the Senate Interior Committee, says that using Pacific Gas & Electric Co. is more economical than using Central Valley Project. The utility could reregulate its hydro plants so that the San Francisco Bay area would benefit. Voltage no higher than 230-kv was found to be economically feasible. American Public Power Association again voice objections and asked Chairman Murray (D., Mont.) to await further studies. Sen. Engle (D., Calif.) told a consumer group that Federal construction of an intertie between BPA and CVP is the "only method" by which rights of preference customers can be preserved.

PACIFIC NORTHWEST ACCOUNT bills in both Houses received vigorous support from Interior Department, National Reclamation Association, and Bonneville Power Administration. Some opposition was expressed by public power groups in Washington State, by consumers who fear rate increases, and some Congressmen from eastern states. Consensus of hearings in both Houses is that private power has little or no objection to the legislation.

REA CO-OPS are likely to be sheltered this session in an election year. Rep. Perkins (D., Ky.) predicts the House Agriculture Committee will not report "harmful" legislation, and Sen. Cooper (R., Ky.) has told co-op leaders their interests "will be protected and safeguarded."

NEW TVA STEAM PLANT, to cost $100-million and produce 500,000-kw, will be located in southeastern Kentucky or eastern Tennessee. An $8.8-million contract has already been awarded for the first turbine generator. TVA plans to make it a 3- or 4-unit plant. Sen. Cooper (R., Ky.) views it as a boon to the depressed coal industry.

INDUSTRY SIFTINGS

NEW CAPACITY SCHEDULED to be added to the nation's generating capability in 1960—12,383,330-kw—is up 3.9-percent since Oct., according to EEI's Year-End Power Survey. Production of all types and classes of heavy electric power equipment dropped off in '59 except for hydraulic turbine manufacture, which exceeded the '58 record. On order with manufacturers now is a total of 2.5-million kw of new generating equipment, and shipments in '60 are destined to be small, says the EEI survey.

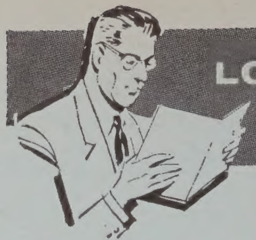
EEI'S "LBE" DROPS TV—To avoid "diluting" its national magazine advertising schedules, the Live Better Electrically Program dropped its proposed network and

local spot TV schedules for 1960, Chairman Geo. Ousler announced.

TIGHT MONEY MARKET is forcing many manufacturers "to intensify their search for increased efficiency in production and inventory management," they reported in a recent NICB survey. So, they admit, this is "a matter of good discipline," forcing improvement in cash management. More than 90-percent of the 228 firms reporting expect to finance 1960 capital spending wholly from internal sources.

"AN IMPOSSIBILITRON" is what Joint Congressional Committee Chairman Clinton P. Anderson thinks about sometimes when he looks at the "atoms-for-peace" program, he told members of the Congressional Club recently. "But I would much rather consider it a Perhapsatron and believe that someday, God willing, it will be a Successatron." Referring to an AEC official's prediction in 1955 that the U.S. would have about 5-million kilowatts of nuclear power by 1960, he lamented the fact that only one large-scale power reactor (Shippingport) has operated to date. (Meanwhile, the Census Bureau reports that atomic energy product shipments from private industry increased to $148.9-million in 1958, up 55-percent over 1957.)

IRRIGATION CUSTOMERS served by the Douglas County PUD will have their meters read only twice yearly, and interseasonal (Sept. to May) usage is to be billed at 1.2-cents per-kwh after a May 1 reading, with no demand charge. Advantages: reduced accounting costs . . . and elimination of damages to growing crops by the meter reading vehicle.



LOOKING AHEAD... FINANCIALLY

—From Irving Trust

New money financing in January totaled $192,593,000 (85-percent electric), down from monthly totals of October, November and December and below volume in January of 1959.

Two AAA rated electric offerings during January—$20-million of Kansas City Power & Light 1st 5's of 1990 on the 7th and $25-million of Connecticut Light & Power (Negotiated 1st 4-7/8's of 1990 on the 21st—had refunding protection for five years and each issue was well received, the Kansas issue yielding 4.95-percent to the public and Connecticut yielding 4.93-percent to the public.

One AA electric offering—$30-million of Southern California Edison 1st 5's of 1985 on the 27th was well received at a yield of 4.93-percent to the public (refunding protection for five years). One A rated electric issue—$10-million of Washington Water Power (Negotiated) 1st 5-3/8's of 1990 on the 7th, with refunding protection for five years and priced to yield 5.30-percent to the public, was fairly well received.

The $5-million of Washington Water Power (Negotiated-BAA) 5-5/8-percent sinking fund debentures of 1985 on the 7th to yield 5.55-percent to the public —(refunding protection for five years) was well received. The only offering of common stock during January was the 200,000 shares of Kansas Gas & Electric on the 20th to yield 3.49-percent.

THE IRVING TRUST INDEXES SHOW:	Bond Averages	December 31, 1959	January 31, 1960
		% Yield to Maturity	
	"Aaa"	4.74	4.72
	"Aa"	4.78	4.75
	"A"	4.99	4.89

Stock Averages	Preferred—$ Yield		Common—$ Yield		Price/Earnings Ratio	
	12/31/59	1/31/60	12/31/59	1/31/60	12/31/59	1/31/60
	5.04	4.96	4.24	4.32	17.6	17.2
	5.16	5.08	4.43	4.53	17.4	16.9
	5.30	5.21	4.38	4.40	16.0	15.7

The Safety Record—Good to Set, and Sell

Safety is becoming, more and more, a subject electric power companies talk about . . . to capitalize on their own improving performance. Not the policy of all utility companies, this approach of really promoting the record is proving highly effective for many. And, the results—in furthering the cause of safety, as well as helping to develop a useful image of the company—are of inestimable value.

Every company doesn't break a record every year, naturally. But, when it does, it's the alert utility that makes the most of it.

Here are some recent examples:

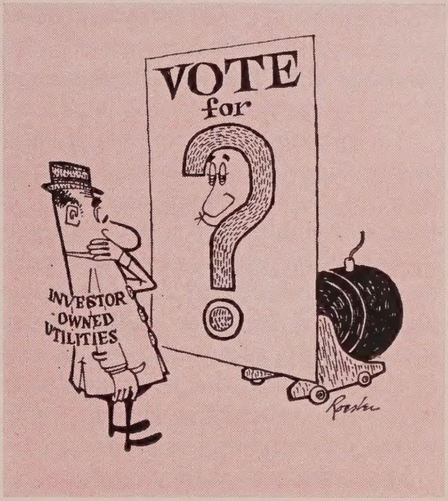
Georgia Power Co. proudly announced last month that its 5400 employes "recorded one of the best years in the company's history during 1959—completing the year without a single fatality and with only 15 accidents serious enough to cause loss of time from work."

That infrequency of "serious" accidents happened only once before in the company's past (in a year when a fatality occurred), Georgia's Pres. John J. McDonough conceded in his announcement. And this past year, Georgia Power rolled up more than 10.5-million man-hours, which included a stretch of more than 2-million consecutive man-hours and another of more than 1-million without any disabling injury (winning EEI's "Million Man-Hour Awards" for these achievements).

Then, there's a long record going at the Cleveland Electric Illuminating Co.—over five (lost-time) accident-free years, involving nearly 3.5-million man-hours for some 350 employes! CEI's Electrical Operation Department Employes have handled over 600,000 electrical switching operations a year in compiling this enviable record.

"Every effort is being made to keep the record going," promises CEI Dept. Supt. K. E. Stafford. "A proper attitude toward safety is the key to our record," he notes, "and safety is a way of life with our people."

And, safety can be demonstrated—and dramatically—in more places than just those involving the more "dangerous" electrical operations, of course. Take Central Hudson Gas & Electric Company's performance in its road work, where the utility's vehicle operations have won national recognition. This utility can and does boast of holding "the finest road safety record compiled by any American electric company."



Utilities Ponder Role—

Politics: Encourage More Participation?

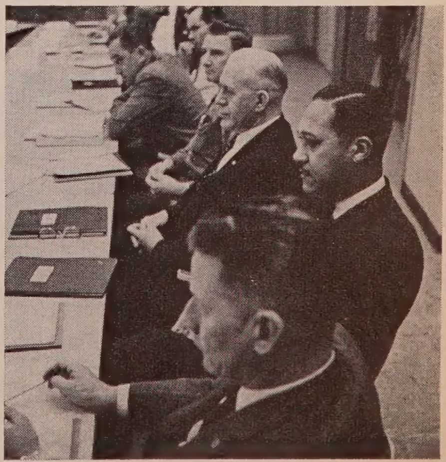
Should American business and industry take—or encourage—more active participation in political matters? The answer has been echoed from industry meeting to industry meeting . . . a resounding YES. But as to how best to get in, there is more confusion than agreement.

It is a little strange that the concept of business in politics should be received as something of an innovation, a relatively new concept. Through lobbying groups and political friendships, of course, business has been "in politics" since time immemorial. The feeling now seems to be, however, based on the philosophy that all business groups and industry groups must give up their own little spheres of influence and aim at the good of the entire business world. This altruistic feeling is fine as far as it goes, but people are people, and self interest is a mighty strong motivator.

While business in general is exhibiting increasing interest in the possibilities of encouraging wider activity in the political arena, there are those who feel the results will

(Continued on page 60)

To stimulate thought . . .



. . . and understanding . . .

(Continued from page 59)

be more unfavorable than favorable. This is why most businessmen prefer to avoid identification of their corporate homes with the actions of individuals in their organizations — from top executives on down the line.

There are formidable barriers. For one, as Arnold H. Maremont, chairman of Allied Paper Corp., told a recent business and industrial management conference: "When corporations enter political fights as a corporation, it spurs the efforts of labor to organize more effectively and to push its own programs with even greater force."

Moreover, such a result could only serve to defeat "business" in its most basic objective of strengthening its own house first—and that involves selling the "fundamental fact" that American workers are not the opposition of business management, but are themselves an essential part of American Businesses. General Electric's Vice-President Jack S. Parker, speaking recently on the subject, noted that "public misunderstanding about the mutuality of employee-business interests stemmed from the monopolistic structure of unions . . . wherein the single tool of greatest use of today's union official is his ability to set employees against management and to nourish the preposterous fiction that hurting a business can somehow help its employees."

If, on the other hand, employees can see eye-to-eye with business management in matters involving "outside" influences on their mutual welfare, more might be accomplished.

Where, then, could employees and management demonstrate this mutuality of interests more dramatically than in political action—motivated by common need aimed toward common aspirations?

Proof that Mr. Maremont speaks knowingly comes from statements like this one of AFL-CIO President George Meany: "The scene of battle is no longer the company plant or picket line. It has moved into the legislative halls of Congress and the state legislature."

As important as union-management relations are, though, this motivation for political alertness is less significant for most business leaders than is the growing desire to act politically to help preserve our way of life. For today, many feel strongly about the seriousness of the threat to the very existance of the free enterprise system, upon which our economy is based.

The electric utility industry — competing directly with government—is perhaps in a better position to understand this problem than any other industry and business group. Other businesses and industries feel the pinch of government regulation in certain areas . . . pricing, licensing, financing. But their operations are only subject to controls. In general, the question of survival is not very strong.

As we enter the 1960's, the electric utility industry, more than any single industry in the country, is in the position of losing all the gains it has made over the last 50-years. Direct competition by government-owned or financed agencies is pressing ever closer. The limits within which investor-owned utilities must operate are becoming more and more stringent and confining.

It is easy to see why many leaders feel that people in the utility industry must take an active part in political matters if the industry is to survive.

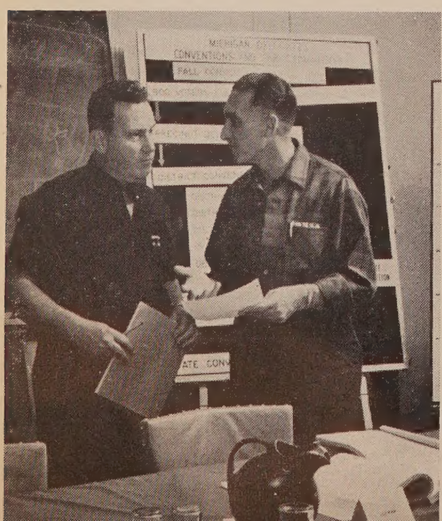
Such participation must be based on one foundation—education. The average employee in the electric utility industry, or in any other industry for that matter, knows surprisingly little of the workings of government. He knows little of how candidates are nominated or of how candidates should be rated on the basis of issues. In spite of our high average educational level in the U.S., we are not politically oriented in our thinking. Any program aimed at encouraging participation must be set up to improve this weakness.

Such programs currently in operation or being planned offer courses in applied citizenship for all employees, entailing both economic and political education. A typical program advocates that each member company have *every* employee devote one and one-half hours every month to conference discussions concerned with company and industry problems. Source materials for the courses can be developed from a number of sources, including the U.S. Chamber of Commerce, National Association of Manufacturers, as well as individual companies such as General Electric.

In the past year, for the first time, the Edison Electric Institute program encompasses an industry approach to this area, too. In its new Customer, Employee and In-

(Continued on page 63)

. . . of political processes



. . . and the economic system is goal of Detroit Edison's program.

by RALPH ELLIOTT
Washington Editor

Electric Co-ops are Losing Their Political Sanctity

REA-financed electric co-ops appear to be headed toward seriously weakening the backbone of political protection under which they have thrived for nearly 25 years. At least that's the indication stemming from some developments that are working a definite change in the complexion of the federally-financed rural electrification program.

With each passing year during the decade just closed, it became more and more apparent that the electric co-ops were turning at a fast clip from the struggling little farmer groups of the '30s and '40s into large and prosperous business enterprises. Some of the statistics covering their growth and improved financial condition in the year 1959, as reported by REA last month, serve to re-emphasize what has been going on in "rural electrification."

For example, the 25.3 billion kilowatt-hours sold by the REA co-op systems in 1959 was 15.5 percent over 1958 sales. The 139,000 new consumers added were 10,000 more than the year before.

Operating revenues rose 9.8 percent, totaling an estimated $618.3 million. Net margins totaled about $87.7 million, up 16.6 percent over 1958 after deductions for expenses, depreciation and interest.

And there was marked improvement in financial condition. Net worth of the electric borrowers at year-end was $602 million, or 18.2 percent of total assets. At the close of 1958 net worth stood at 16.6 percent of total assets.

A big factor in this picture of prosperity, of course, is the subsidy gimmick by which the co-ops still borrow from REA at the statutory 2 percent interest rate, with the taxpayers picking up the tab for the difference between that rate and what it actually costs the government to borrow long-term money (now well over 4 percent).

As the co-ops have fattened, the Eisenhower Administration has repeatedly tried to pull them away from the subsidy trough by urging Congress to raise the REA interest rate to the level of the "going rate" paid by the U. S. Treasury on long-term borrowings. And each time Congress, in the name of political expediency, has all but ignored the President. Behind this legislative cold-shoulder has been the conviction that the "rural electrification" program was still widely accepted as something the government ought to be doing to ease the burden of the farm folks' chores. So the cold political fact as seen by re-election-minded members of Congress (whose numbers constitute a vast majority) has run about like this: action regarded as adverse to farmers on the REA issue is bound to lose big chunks of rural votes; but no action at all stands to lose few if any urban votes.

Now, however, the picture is beginning to take on a change perceptible enough to foreshadow the possibility of a turning point in the foreseeable future. Some legislators who have been consistent supporters of the status quo in REA interest rates are privately admitting a doubt that such support will continue to yield its past level of dividend in political pay-off. They are beginning to sense that public knowledge of the changes taking place in rural America and in "rural electrification" is spreading through many suburban areas and into the adjoining cities. Farm areas are not as isolated from city eyes and ears as they once were.

A prime fact of life that seems to be "sinking in" is that over 96-percent of U. S. farms already have been electrified—in other words, that practically all of the money loaned by REA in the future is going to be used to meet the electric power demands brought on by increasing farm automation, and to serve non-farm consumers. During 1959, according to REA, five out of six consumers added to REA-financed lines in the continental U. S. were non-farm consumers. It will take faster and faster footwork to defend 2 percent loans to finance that kind of co-op business.

An eruption that could further spoil some of the co-ops' rosy "farm organization" complexion has developed from their rash of skirmishes with urban electric systems over who should serve suburban areas which are rapidly expanding into once-rural sections. The chances are such goings-on will disenchant many co-op supporters.

Another development indicating the co-ops' future may not be as politically secure as in their past, is seen in the House Ways and Means Committee hearings (due to be held before this goes to press) looking toward the possible federal taxation of the income of all co-ops, including electric. The fact that Democrats controlling the committee are willing to open up the subject to public scrutiny is of more than passing significance.

Obviously there is no chance for increasing electric co-op interest rates, or putting a federal tax on co-op income, in this election year. The co-ops are still sufficiently entrenched politically to ward off either blow. But the reverse swing of the pendulum is picking up momentum and will be well worth watching.

It looks like the day will come when these much-shielded groups can no longer duck the responsibility to carry their own weight in the national economy.

REGULATORY  **REVIEW**

New York PSC Reverses Its Position On Conjunctional Billing

In an unprecedented reversal of an earlier finding, the New York Public Service Commission ruled that the conjunctional billing of existing customers could continue into the indefinite future. While the Commission in its May 26, 1959 Opinion and Order had noted that conjunctional billing was "unduly discriminatory and unjustly preferential and should be discontinued," it had its mind seemingly changed by the political persuasiveness of the City of New York. In the new Order of January 12, 1960, it noted that the problems of conjunctional billing are *"so complex as to be indeterminable with completeness and accuracy, and so widespread and drastic under most, if not all, alternatives as to prompt us to terminate our current quest for fair and feasible means of immediately limiting the number and scope of some or all of the present accounts."**

Commissioner Mylott's dissent in this Order is noteworthy not only as to matters of regulatory law which the Commission must uphold, but also as to the economic equity prohibiting conjunctional billing. To that extent it is worthy of an extended quote. Commissioner Mylott said in part:

"I regard the majority decision, which reverses the position taken by the Commission in its earlier decisions in these proceedings--a reversal that is unprecedented so far as I know, as having the effect of bypassing or ignoring in this instance our continuing duty under the provisions of the Public Service Law.

"Among the important provisions of the Public Service Law which the Commission is required to enforce is Subdivision 3 of Section 65, which reads:

> 'No gas corporation, electric corporation or municipality shall make or grant any undue or unreasonable preference or advantage to any person, corporation or locality, or to any particular description of service in any respect whatsoever, or subject any particular person, corporation or locality or particular description of service to any undue or unreasonable prejudice or disadvantage in any respect whatsoever.'

"In the decision adopted by the Commission on May 26, 1959, it was unanimously concluded, after a thorough and exhaustive review of the evidence and of the contentions of all parties to the proceedings, that conjunctional billing and intercommunicating buildings riders are 'unduly discriminatory and unjustly preferential, and should be discontinued.' (Opinion p.270.)

"This finding was unanimously confirmed in the decision adopted by the Commission on July 27, 1959, wherein the Commission granted an oral argument to give the protestants an opportunity to show how the intent of the Commission's original decision could be accomplished with less of an impact than had been claimed in some instances. The decision of July 27, 1959, stated:

> 'While the applications for rehearing do not prompt us to change our determination that the practice of conjunctional billing is unjustly discriminatory and should be prohibited in the future and restricted in certain present cases, if not in all, we feel that the issue is of sufficient importance that the applicants for rehearing should be afforded an opportunity to present their positions orally before the full Commission, particularly in respect to whether the intent of our decision can be accomplished with less of an impact than that which has been claimed in certain instances.'

"No new arguments were presented at the rehearing. The arguments of the intervenors, as the record shows, were a rehash of arguments and contentions that had been advanced during the course of the hearing and in the briefs filed following the hearing and in the petitions for rehearing, and the Commission's decision of January 12, 1960, makes no finding to the contrary. In other words there is nothing of record before the Commission that it had not fully considered when it stated in its July 27, 1959, decision granting a rehearing that 'applications for rehearing do not prompt us to change our determination that the practice of conjunctional billing is unjustly discriminatory.' Therefore, the present determination by the majority of the Commission is made on essentially the same record and arguments that were before it when its original decision was unanimously adopted.

"Indeed, my understanding is that the present majority opinion, from which I am dissenting, does not reverse the prior determination that the conjunctional billing practice permitted under the riders is unjustly discriminatory. On the contrary, the majority opinion specifically points up some of the discriminatory aspects of the practice, but nevertheless concludes, unjustifiably I think, that the only relief which the Commission should grant is to 'limit the scope of the *privilege** to customer accounts'

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* Italics supplied

that were benefiting by the practice prior to June 1, 1959.

"It is my opinion, as previously indicated herein, that the original determination that conjunctional billing is 'unduly discriminatory and unjustly preferential' makes a continuation of the practice illegal under the provisions of the Public Service Law which I have quoted. Therefore, I can not acquiesce in a decision which, in my opinion, ignores the clear mandate of a statute which the Commission is duty bound to follow.

"I do not believe there is legal or factual justification for the majority conclusion:

> ' . . . that the ramifications of sudden cessation of the existing conjunctional billing privileges, in whole or in major part, are so complex as to be indeterminable with completeness and accuracy, and so widespread and drastic under most, if not all, alternatives as to prompt us to terminate our current quest for fair and feasible means of immediately limiting the number and scope of some or all of the present accounts.'

"The evidence of record supports the soundness and legality of the Commission Orders of May 26, 1959, providing for an immediate modification of the conjunctional billing riders and for their complete termination over a transition period ending July 1, 1964.

"The majority opinion erroneously refers to the Commission's 1951 Order 'freezing' non-residential submetering as a precedent for 'freezing' conjunctional billing. To anyone familiar with the earlier proceeding, it is obvious that there is no analogy whatever between the two practices. The submetered consumer pays the same rates that he would pay for a like amount of service if he were supplied as a direct customer of the company. On the basis of the record before it, the Commission approved the elimination of residential submetering and ordered a freeze of non-residential submetering not on the ground that the practice resulted in discrimination as between consumers, but on the stated ground that 'the practice of submetering is parasitic and undesirable.' The decision in the submetering case pointed out that the submeterer 'competes with the central station service by selling to the ultimate consumers' and that 'the profit to submeterers would be available either for reducing rates to other customers or as an aid in maintaining the level of rates in a period of rising costs' (See Opinion in Case 14279, pp. 92-93, decided July 25, 1951). In other words, the elimination of submetering profits affects all consumers, other than the submeterers in the same fashion. The higher rates for submetering tend to remove unjust discrimination against other customers; but because rider customers pay lower rates, the other customers are adversely affected by the continuation of the riders.

"The majority opinion contends that 'The passage of time will serve to contract the scope and extent of the present conjunctional billing practices as title transfers lease terminations, building destructions, etc. disrupt the present combinations.' Then it is stated that 'For now, at least, we propose to rely only thereupon for such contraction.' This is most certainly a fallacious hope unless the phrase 'For now' is an indication that a new proceeding concerning conjunctional billing practice will be instituted in the near future. What prospect, for example, is there that a number of public housing projects now being served under the riders will be removed from rider billing because of title transfers or building destructions? It is almost certain that the number of kilowatt-hours and the revenue billed to customers who will continue to enjoy the conjunctional billing privilege will increase; installation of air conditioning units in housing projects would greatly increase sales to such projects; greater use of electrical appliances of many types and purposes and, also, better lighting always tend to increase the consumption in residential, commercial and industrial properties.

* * *

"The company has a statutory and constitutional right to earn a fair return upon its property. It obviously follows that, since the approximately 6,000 rider customers (electric, gas and steam) are concededly receiving an undue preference in rates, the remaining 3,994,000 customers, who are unorganized and individually too small in consumption to employ expert legal and other professional talent to represent them, will, of necessity, be required to continue to pay more than their fair share of the total bill for service. It is the duty of the Commission to have all customers in mind when it makes a decision, but by their action now the majority of the Commission completely ignores the interests of a great number of small and uninformed customers."

Politics . . .

(Continued from page 60)

vestor Relations Division, EEI is endeavoring to "close the gaps in employee understanding." The Committee's Chairman, President Charles E. Oakes of Pennsylvania Power & Light Company, summarized their activities recently (EL&P, January 1, 1960, page 35):

"Employees make up the key group in communicating what the electric companies are and how they serve the public. We have found that there are serious gaps in employee knowledge and understanding, not only of their own companies and industry, but of the American economic system as well. Accordingly, we have urged that companies allot time to regular monthly conference sessions, in which small groups of employees discuss matters of importance to their company and the industry as a whole. The Institute has two employee courses, "The American Economic System" and "American Freedom" already available and in use, and a third on the economics of the utility business, in work."

An example of the program in operation is the applied citizenship course given by Detroit Edison for its employees. To start the program, the company had a public affairs organization train 20 employees as group leaders. These leaders work in teams of two in conducting the discussion groups of 20 employees per group.

Meetings are held once a week, for two hours at a time, and continuing for a period of 10 to 12 weeks. Management and staff em-

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NUCLEAR NEWS

COMPETITIVE NUCLEAR POWER is here now, former AEC reactor chief, W. Kenneth Davis, told the First Canadian Conference on Uranium and Atomic Energy in Toronto on Jan. 12. "Within a few years nuclear power will be competitive with conventional steam power plants in the U. S. on a general basis," he predicted, "(and) today it appears possible to build in high fuel cost areas of the U. S. large nuclear power plants which will prove to be economical over their useful lives. We do not believe it unlikely that the cost differential of $60 or $70 per kilowatt above a coal-fired plant will be reduced by about half within a fairly short number of years and that fuel cycle costs will be reduced to 2.0 mils per khw or slightly less."

ACCELERATED U. S. A-POWER PROGRAM, Rep. Chet Holifield (Dem., Cal.) told the same Canadian Conference, should include full development of the reactor concepts which the Canadian AECL is pursuing—the heavy water-natural uranium type, and the organic concept. "Discussions are now underway for an expanded cooperative program (between the U. S. and Canada)," the Joint Congressional Committee member noted. "In addition to the mutual use of reactors and nuclear facilities, this expanded program will include ten specific areas of research and development of mutual interest, which will be closely integrated. Included will be such key items as the development of improved fuel elements, improved pressure tubes, improved components and seals, and improved engineering techniques for reducing capital costs of the structures."

ABOUT URANIUM MARKETS, Cong. Holifield told the Canadian audience: "I am confident that we will see the day not so far distant when we will have to extend ourselves in the U. S., Canada and throughout the world, to obtain the necessary uranium raw material to supply the expanding civilian market."

CANADA SPENDS $25-MILLION A YEAR on atomic energy, the Canadian Conference learned from John Davis, director of research and planning for the B. C. Electric Co., Ltd. "This is about the same number of dollars as our electric utilities are paying for their supplies of coal, oil and gas. But, we still do not know whether it makes more sense than any other sequence of investment which is open to the Canadian government, (which) could, for example, spend a few million dollars on long-distance transmission. It could do more about unlocking the vast amounts of energy tied up in Alberta's tar sands. It could look into better methods for processing our uranium and other mineral resources," suggested Mr. Davis. (A Canadian atomic industrial association is being formed, it has been reported recently.)

STATE-OF-THE-INDUSTRY hearings in progress this week on the Hill will again help to bring the atomic energy development picture into focus, not only for the Congress, but for private industry interests, many of whom are still more concerned than reassured about how things are going. Newly available for reference, incidentally, is the Index to Hearings held in Feb. of 1959, identifying, of course, the broad scope of testimony and individuals and organizations contributing views on the "growth" situation. (Copies of it and the hearing proceedings are available on request to the Executive Director, Joint Committee on Atomic Energy, The Capitol, Washington 25, D. C.)

TEST REACTOR IRRADIATION requirements are estimated to total some 1600 capsule tests for the period 1960-1965, industrial companies reported to the AEC in a recent survey. While the bulk of these were reported to be "speculative" needs, these test requirements would be expected to become "firm" in the later years of the five-year period. Greatest number of reported estimates call for an average neutron flux of 1 to 2.5 x 10^{14} n/cm^2/sec, a hole diameter of 1⅛ to 3 inches, and a capsule length of 6 to 12 inches.

PEACH BOTTOM STATION being planned by the Philadelphia Elect. Co. for construction by 1963 is to be under the supervision of Vincent S. Boyer, who has been serving the utility as superintendent of its Cromby station.

UAW PETITION ON PRDC—New hearing on the prolonged case of the union effort to intervene in the Power Reactor Development Co. project at Lagoona Beach, Mich., has been set for some time in March, by the U. S. Circuit Court of Appeals. (Union petition, of course, objects to AEC findings that the reactor can be built and operated safely.)

NEW LEASE AGREEMENT for special nuclear material, proposed by the AEC, is to be effective March 1, after a postponement of 30 days. Under the new agreement, a single signed agreement by the lessee and the Commission will set forth the terms and conditions for all special nuclear material transactions for the account of the lessee.

PATHFINDER PROJECT construction permit, applied for by Northern States Power Co., was scheduled to be the subject of a public hearing on Feb. 15.

REACTOR SAFETY STUDIES at the National Reactor Testing Station moved another step forward earlier this month when the AEC issued plans and specifications for construction of the SPERT IV (Special Power Excursion Reactor Test No. 4) facility. Firms bidding on the $1.3-million job are given four weeks to respond to the invitation, with 400 calendar days estimated as the construction time involved.

Study Transformer Load Characteristics

Union Electric and Westinghouse Electric Co. are jointly studying residential load characteristics and their effect on distribution equipment.

To obtain necessary information on transformer loadings in representative locations, 30 transformers in St. Louis City and County were selected by a sampling process and are being studied over a 15-month period. Each transformer is being surveyed by two load survey recorders which will measure both kw and kva load.

The devices record on magnetic tape electrical impulses proportional to the load and to electrical time-interval pulses. In addition, they include a meter which totals the kwh consumption of the customers served by the transformer. Providing a 32-day record of the transformer load, the 600-ft tapes are changed monthly and forwarded to Westinghouse.

At Westinghouse, the information is transcribed to punched cards and fed into computers which analyze the load information and characteristics, including daily and annual load curves.

As part of the survey, customers served by the test transformers will be interviewed by Union Electric Residential Sales personnel to obtain complete information about their electric appliances, service entrance capacities and other pertinent information. Each customer's monthly kwh usage will be provided by the Customer Accounting dept. This information will be used to relate individual customer kwh consumption to the total demand on the transformer.

Information obtained in the study will be used in checking present transformer loading practices and, if necessary, modifying them to provide the most economical loading for reliable and efficient service.

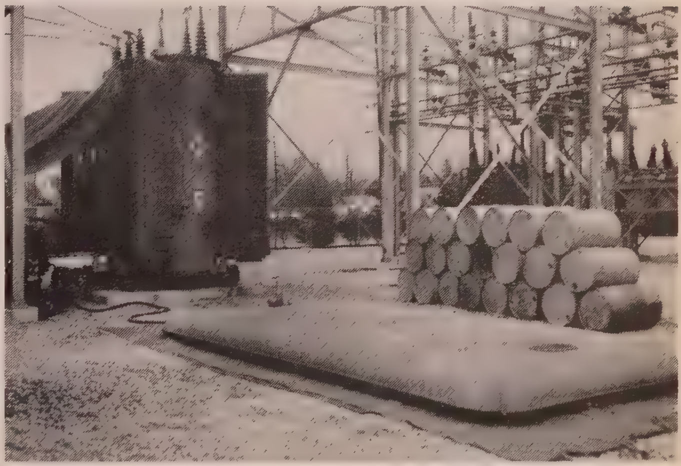
Install Automatic Rubber Goods Testers

A completely automatic rubber glove tester with fool-proof safety devices has been installed by Public Service of Colorado. It will test eight gloves at one time at voltages up to 18 kv.

A new rubber blanket testing machine has also been put into use. Although it is a separate device, it is electrically connected to the rubber glove tester and operates from the same control panel.

Approximately 125 pairs of gloves and 81 blankets are tested in the lab each month.

Transformer Oil Rests In Big Pillow



Here the "pillow tank" stores 1500 gallons of oil drained from a 20-mva transformer during field maintenance operations at a LILCO substation. At right are some of the 30 steel drums that would have been needed prior to the "pillow's" installation.

A 3000-gallon collapsible container, shaped like a large rectangular flattened pillow, is enabling Long Island Lighting to more quickly and safely perform substation equipment maintenance. The synthetic rubber "pillow tank," recently purchased from Goodyear Tire & Rubber Co., is being used to aid in the repair of oil-containing units such as substation transformers and circuit breakers. Since oil in such equipment must be drained before maintenance work can begin, convenient storage facilities are desirable. Before the "pillow tank" was used, it was necessary to store the oil in steel drums, interrupting drainage as each drum became full. The reverse process of returning oil was similarly a disjointed operation. Removal of 1500 gallons—not extraordinary in transformer maintenance—meant juggling 30 drums and took two hours.

The same operation with the "pillow tank" is a continuous process requiring only 45 minutes. In an emergency situation, as well as in normal field maintenance, the substitution of this single, compact 320-lb unit for the great weight and awkwardness of up to 60 drums means a much quicker start and a faster completion of needed repairs.

LILCO is the first utility on the east coast to apply to its operations this handy, light-weight storage container. In larger sizes, ranging up to 10,000 gallons, the "pillow tank" has been used by the Air Force for fuel "para-drops" and has been towed through the water by merchant ships for added fuel storage.

POWER STATION VULNERABILITY TO NUCLEAR BLAST

Exhaustive study conducted for U. S. Air Force permits prediction of patterns of recovery from nuclear blast for power plant and switchyard electrical equipment and for associated structures.

By E. T. B. Gross - - - - - - and - - - - - - D. B. Singer

Professor of Power Systems Engineering, Illinois Institute of Technology, Chicago; and Consultant, Armour Research Foundation

Assistant Supervisor of Structural Mechanics, Armour Research Foundation of Illinois Institute of Technology, Chicago

AN ASSESSMENT OF critical overpressures from nuclear blast for power station electrical equipment and structures, together with repair or replacement times, is provided herein for the benefit of the electric utility industry. This has resulted from a special study[1] to determine the gross vulnerability of a specific central station to air blast.

As background information, a brief description of the actual station studied is provided. Next, the principal assumptions upon which the study was based are described. Finally, the vulnerabilities of principal items of equipment and structures are reported: This includes a description of how the blast load was predicted, how the response of the structure was computed, and how estimates were made for damage and subsequent repair of electrical equipment. The results are summarized for all items of equipment studied.

[1] "Vulnerability of a Thermal Electric Power Plant to Air Blast," Physical Vulnerability Division, U. S. Air Force, Contract No. AF33(038)27011.

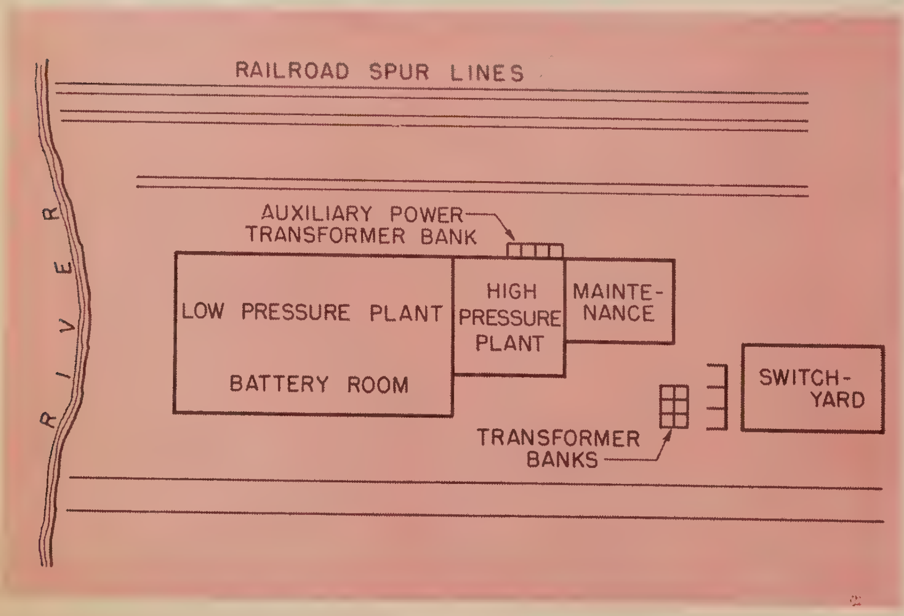
Description of Station

Essentially two plants are involved: The low-pressure plant and the high-pressure plant. A plot of the station is shown in Fig. 1.

The low-pressure plant, with a nominal capacity of 187 mw, consists of six units which were put into operation between 1920 and 1923. The high-pressure plant, which is of modern construction, is referred to as Unit No. 7. This unit produces more than half of the total output of the low-pressure plant, its capacity being 107 mw. Rated capacity of the station is therefore 294 mw, but it is referred to as a 300 mw plant.

The boiler room, turbine room, transformer house, switch house, and offices occupy the main building, which is about 700 feet long and 300 feet wide. The roof of the boiler room is about 110 feet above ground in the low-pressure plant and 150 feet in the high-pressure plant. There are five 16-ft-diameter self-supported steel stacks atop the low-pressure plant, and two 11-ft-diameter steel stacks atop the high-pressure plant. The tops of all stacks are 300 feet above ground. The walls are of heavy, 16-in. brick masonry construction. A repair shop attached to the main building and the high-voltage 69-kv switchyard and transmission terminal also are on the property.

Fig. 1. Simplified plot plan.



Basic Assumptions

It was clear that no analytical

techniques existed, or could be developed in a short time, for treating the tremendous complex "central station" as a responsive entity. Further, in predicting recovery, one would have to consider practically our entire industrial economy in order to make realistic estimates of recuperability. For these reasons the following major simplifying assumptions were made:

1. The attack weapon was a so-called "nominal" bomb, of the type used in World War II. Peak overpressures and durations developed by such bombs are detailed in "The Effects of Nuclear Weapons," U. S. Government Printing Office, June 1957, Washington, D. C.

2. The displacements of structural elements and items of equipment could be approximated by computing the displacements of suitably-chosen simple mass-spring systems, or other appropriate models.

3. The station alone would be the object of a nuclear attack which would not damage any other part of the industrial community. In predicting recovery, therefore, it was further assumed that all emergency requirements for manpower, materials, and transportation could be met.

Vulnerability Stages

Vulnerability of every item considered was determined by a two-stage sequence which included loading and response. These stages are amplified briefly below.

Loading

Loads assumed to develop in equipment and structures were estimated by dividing the loading cycle into two phases, the diffraction phase and the drag phase. The diffraction phase deals with the initial flow of the shock wave front around the obstacle; during this phase pressures on the surfaces change rapidly. Although the duration of this phase is relatively short, high impulses may be generated which produce critical initial velocities. The drag phase, on the other hand, deals with flow when pressures on the surfaces change relatively slowly.

Actual geometries of items of equipment and structures were ap-

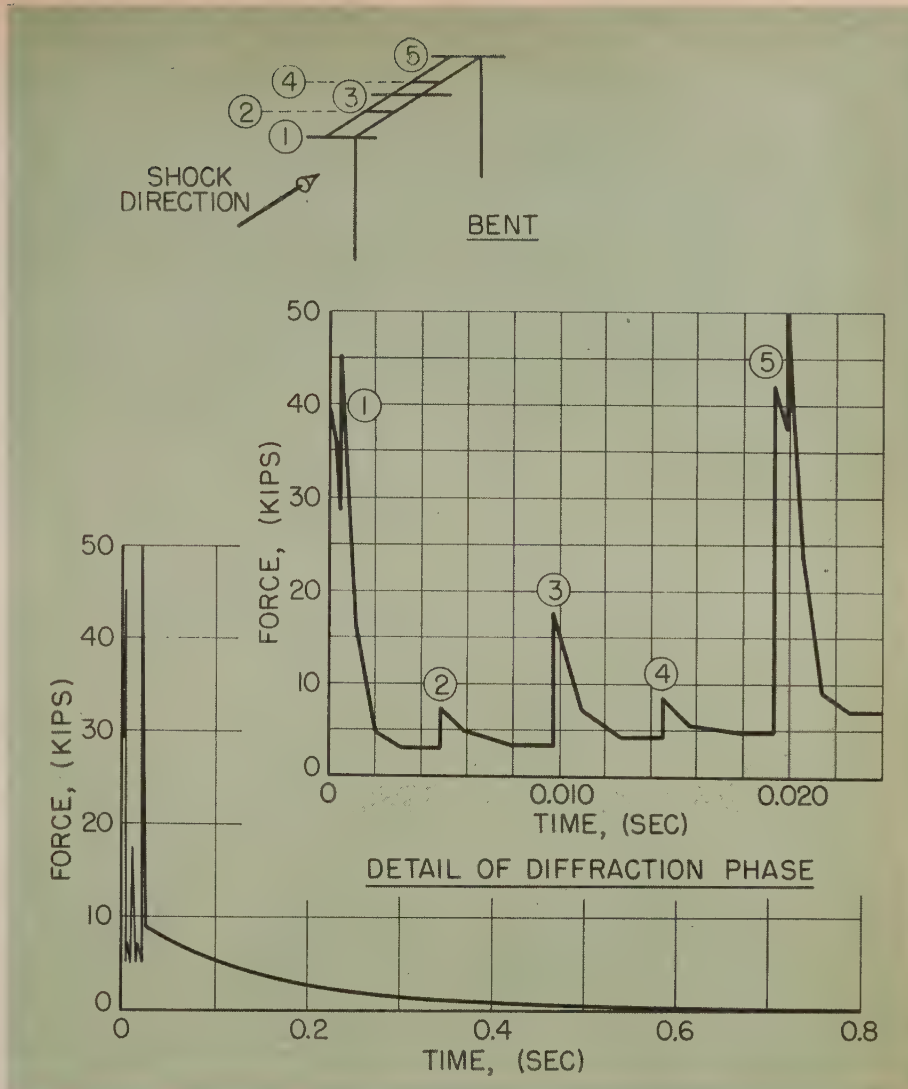
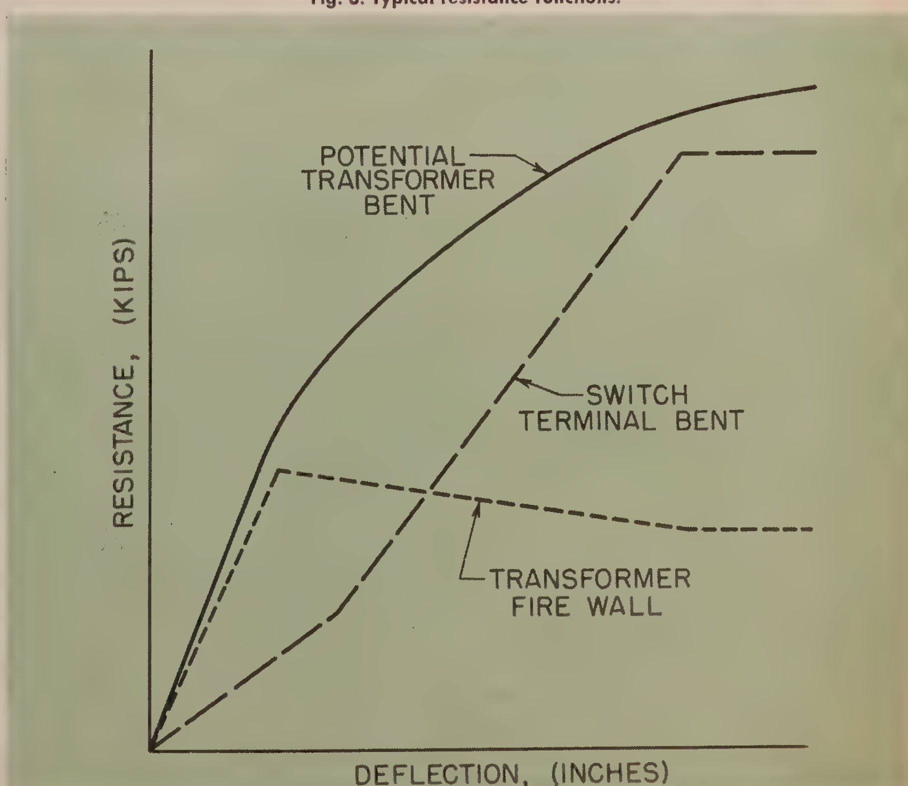


Fig. 2. Loading on breaker terminal bent 4-PSI shock.

Fig. 3. Typical resistance functions.



proximated by simple blocks, plates, cylinders and double blocks, the latter to estimate the effects of shielding and reentrant corners. Using these idealized geometries, it was possible to extrapolate from shock tube, high explosive, wind tunnel and large scale field test data and obtain reliable predictions of net loading.

Actual loadings were carried out in detail for each item considered for only one condition of nuclear blast. To develop estimates for other attack conditions, the load during diffraction phase (the "diffraction load") was assumed to vary linearly with the overpressure of the incident shock wave; the load during the drag phase (the "drag load") was assumed to vary with the square of the overpressure. A typical net load prediction is shown in Fig. 2.

Response

Response analyses were performed on the assumption that, in most cases, the behavior of an elastic continuous, or distributed-parameter, system could be approximated by a mass-spring system having suitably selected inertial and stiffness characteristics. Each case involved a displacement of such magnitude that the elastic limit of the material was exceeded at some point in the structure, and deformations took place well into the plastic range, until rupture developed.

In other cases the mode of response was rigid body rotation rather than elastic distortion. Here the equation of motion was written directly in lumped-parameter terms, since rigid body displacements contributed essentially the entire response.

The Equation of Motion

The governing equation of motion for each item of equipment or structure was of the type characteristic of the single degree of freedom mass-spring system:

$$M\ddot{x} + R(x) = F(t)$$

These terms will be described briefly.

The function $R(x)$ is termed the resistance function, and stems from the elastic (restoring) forces of the disturbed structure. In the case where response deals with over-

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Table I

SUMMARY OF DYNAMIC RESPONSE OF EQUIPMENT AND STRUCTURES AND ASSOCIATED REPAIR TIMES

EQUIPMENT	AVERAGE OVERPRESSURE (PSI)*	DESCRIPTION OF FAILURE	REPAIR OR REPLACEMENT TIME (WEEKS)
Breaker and Supporting Frame, 69 kv	10	Collapse of supporting frame	32
Reactor, 350-amp, Single-Phase, Oil-Immersed, Self-Cooled	23	Overturned	40
Regulating Transformer, 2222 kva	36	Overturned	36
Power Transformer, No. 1 12-69 kv, 20,000-25,000 kva	35	Overturned	52
Power Transformer, No. 2 12-69 kv, 20,000-25,000 kva	25	Overturned	52
Turbogenerator Unit, 107,000 kw	30	None	—
Breaker Terminal Bents	7	Collapsed	32
Potential Transformer Bents	8	Collapsed	32
Transformer Fire Walls	4	Partial Collapse	32
Station Battery	20	None**	16
Electrical Control Panels in Main Control Room	10	Overturned	24

*Average overpressure denotes overpressure outside of building, considering that blast may develop from several directions.

**No damage due to air blast alone. However, complete destruction because of debris from other equipment at 10 psi and above.

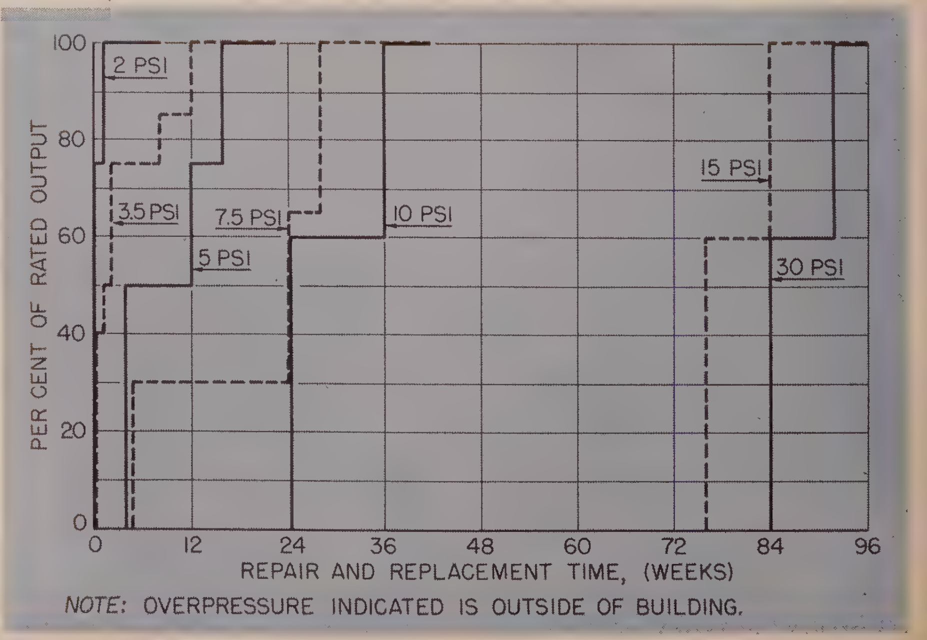
Table II

CRITICAL STRUCTURES AND ITEMS OF EQUIPMENT AT VARIOUS OVERPRESSURES

OVERPRESSURE (PSI)	ITEMS CONSTITUTING BOTTLENECKS TO PRODUCTION[a]
2.0	69-kv disconnecting switches
3.5	Induced draft fan, stack breeching, battery, bushings and insulators, power transformers, 69-kv disconnecting switches
5.0	69-kv disconnecting switches, power transformers
7.5	69-kv disconnecting switches
10.0	69-kv disconnecting switches, steam generator, power transformers
15.0	Main building structure, steam generators
30.0	Main building structure, steam generators

[a]Recovery time required to restore plant capacity is governed by these items.

Fig. 4. History of recuperability trends.



MODEL SHOWS GENERATING CAPACITY AVAILABLE

A new realism in planning is achieved by simulation through use of a mathematical model of system generating capacity that accounts for both chance events and human decisions. Twenty years of daily operating experience, including both expected and unusual happenings, can be simulated in 20 minutes to provide management with a new analysis of operating procedures and a better understanding of system performance.

By C. J. BALDWIN
Electric Utility Engineering Dept.
Westinghouse Electric Corp.
East Pittsburgh, Pa.

J. E. BILLINGS
Electric Generation Dept.
Public Service Electric and Gas Co.
Newark, New Jersey

ENGINEERS have a new tool for system planning with operational gaming, or system simulation, as its foundation.

Briefly, a mathematical model of the power system is created which is essentially a representation of the power system by means of equations and rules. The equations describe mathematically reactions of the real power system to external stimuli, such as load growth. They also describe interactions of characteristics of the power system itself, such as spinning-reserve policy and maintenance programs. Human decisions which affect power-system operation and development are included in the model as formalized rules. Thus the model is equipped to simulate daily operating experience of the power system.

All this is formulated as logic and data within the memory of a digital computer. High calculating speed of such computers makes it possible to simulate twenty future years of daily experience in about twenty minutes. A previous article[1] has explained the simulation concept.

Overall mathematical model of the power system is actually a combination of submodels. One submodel generates the daily loads which confront the simulated system capacity. Another submodel describes that capacity as it is forced out, scheduled out, or run to meet the load. Need for new generation and interconnection capacity is based on daily reserve margins, the difference between load and capacity, as simulated by these submodels. A future article will explain use of these margins in more detail.

Beside the load and capacity submodels, there are programs to plan transmission,[2] to calculate production costs, and to determine capital costs of plant additions. This article, however, is concerned with the generating-capacity submodel and its salient features. Realism and advantages of the simulation approach become apparent as the capacity submodel is examined in detail.

Available And Spinning Capacity Simulated

Available generating capacity is made up of all units not on forced, scheduled, or maintenance outage. Some of this available capacity may not be run for economy reasons, but in times of peak load this capacity on economy outage will be used to meet the peak. If an optimum maintenance policy is followed, shortage in available capacity dictates need for a new unit.

Whether or not an actual peak is carried depends on amount of spinning capacity. Failure to carry the peak may be caused by a shortage in available capacity (all units available running) or by inadequate spinning reserve. The generating-capacity model is designed to detect both system conditions by simulating available capacity and spinning capacity during the peak period of each day.

Available Capacity Components

Daily available capacity is deter-

mined by both chance events and by calculated human decisions. The latter are called deterministic events. For example, occurrence of a forced outage is a chance event while the decision by system operators to shut down a unit for scheduled maintenance is a deterministic event. The model must be able to simulate both types of events to produce daily available capacity.

Daily available capacity of a system equals total installed capacity plus available interconnection capacity minus capacity unavailable because of forced, scheduled, or periodic overhaul outage. The first two quantities are easily obtained. One part of the model is a list giving capacity of every unit on the system. Installed capacity is simply the sum of individual unit capacities.

Interconnection capacity is either maximum capability of interconnection transmission circuits (with estimated allowance for imperfect paralleling) or available capacity of other pool members from the pool model, whichever is less. The third quantity, unavailable capacity, is obtained by simulating individually forced outage, scheduled outage, and periodic overhauls.

Forced Outages

Forced outages are strictly chance events. For any particular unit, they may be considered as a sequence of random occurrences. Time between forced outages of the unit is random, and once an outage occurs, its duration is random. Events like this are best simulated by a Monte Carlo process.

Monte Carlo has been described elsewhere,[3] but briefly, it is applied as follows. Analysis of historical data provides the basis for drawing a curve of probability vs. time between outages and a second curve of probability vs. duration of outage. These curves are input data for the program.

Suppose a unit has just been returned to service following a simulated forced outage. This is the most convenient time for the model to produce date of the next forced outage. It does this by first generating a random number, say between 0.00 and 0.99 after which it enters the curve of time between outages with this number on the probability axis. From the curve is read number of operating days to next forced outage for that unit. Of course, this is a piece of information that is withheld from the deterministic part of the model.

The generating unit is then available for service until it has operated the "randomly drawn" number of days. When this time is up, the forced outage occurs in the model and is duly recorded. Then a similar procedure, using another random number and the other curve, is used to find out how long the outage lasts. The unit is unavailable for service during this period.

Each unit is treated individually. That is, its outages occur in a statistical pattern based on its own characteristics. These characteristics are determined either from historical data or from engineering estimates of future performance. In effect, a curve for each unit may be stored in the computer.

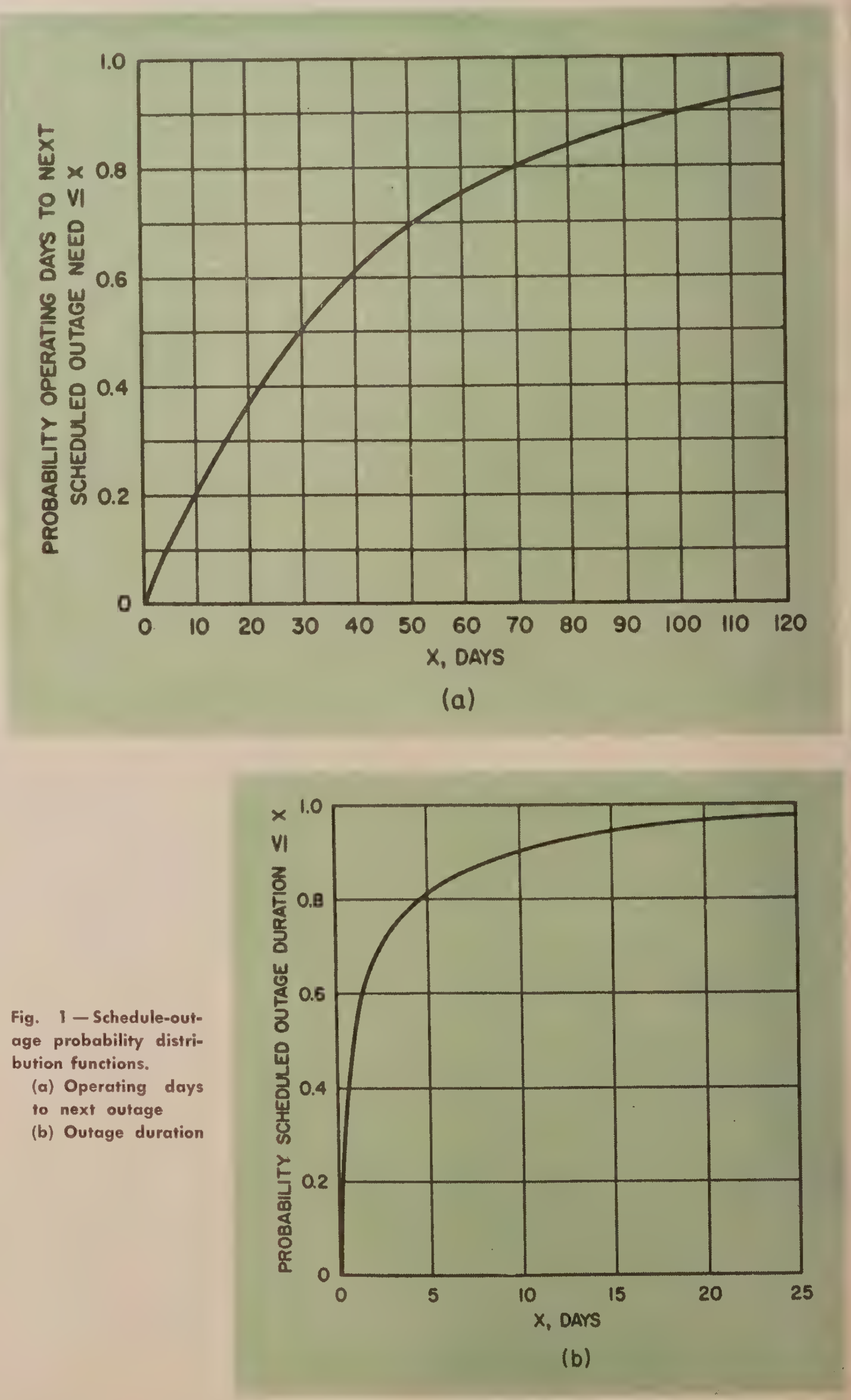


Fig. 1 — Schedule-outage probability distribution functions.
(a) Operating days to next outage
(b) Outage duration

Realism Added To Forced Outages

Partial outages may be very important in determining available capacity. Certain units, for example those with twin boilers, may have more outages; but many of those outages may be only partial reductions in unit capacity. Half outages are simulated by the model to represent this effect. Unit performance data is gathered on both full and half outages. Half outages are defined here as reductions in capacity of from 25 percent to 75 percent of rating. Reductions of less than 25 percent are considered no outage while reductions of over 75 percent are considered a full outage. Probability of an outage being a half outage can be computed for each type of unit from this data analysis. Boiler arrangement has a significant effect on this factor.

Another Monte Carlo draw is used to simulate a half outage. Suppose the model indicates a forced outage on a unit is due, and suppose the probability of half outage is 0.43. A random number between 0.00 and 0.99 is generated by the program. If it falls below 0.43, the outage is a half outage; if it falls above, full capacity is forced out.

Another realistic feature of the forced-outage simulation is ability to postpone outages to the weekend period of low load. Forced outages are defined as those that must be taken immediately or postponed no longer than the weekend period of low load. Study of past performance shows the fraction of all outages that are of the postponable variety. A probability of postponement is obtained, and another Monte Carlo draw will establish whether any given outage is taken immediately or postponed to Friday night.

Is Forced Outage On Or Off Peak?

In addition to simulating forced outages for each unit with respect to day of occurrence, duration, half or full, and postponed or not, the model determines whether or not the unexpected outage occurs during the critical two- or three-hour peak period when spinning reserve must compensate for its loss.

Determination of on-peak or off-peak occurrence of forced outages is accomplished by a Monte Carlo draw process similar to that used for postponing outages. Analysis of historical data has shown that forced outages occur during the peak hour and two preceding hours with a probability of 0.26. When a forced outage on a unit occurs in the model, a random number is generated, 0.00 to 0.99. If it falls below 0.26, the outage is recorded as an on-peak outage, and spinning reserve for the peak hour is committed accordingly. Numbers falling in the range 0.26 to 0.99 designate off-peak outages affecting available margins only.

The model is able to simulate realized spinning reserve from this information along with simulated load-forecast error. Hence, this makes possible studies of policy on spinning reserve.

Simulation Of Scheduled Outage

Forced outages are strictly random, but scheduled outages are not. While chance events create the need for scheduled outage and determine the outage length, actual date that the work begins is widely postponable by human decisions. To simulate scheduled outages properly, a model must represent both random events and consequent human decisions. Consider the random events first.

The random need for scheduled maintenance and random duration of the ensuing outage can be described using probability distributions based on historical records of scheduled outages taken. Each unit may be represented by its own characteristic distribution, just as it is for forced-outage simulation. Fig. 1 shows typical distributions for (a) operating days to next repair need and (b) subsequent scheduled outage duration. Distribution of (a) is exponential in shape and is characteristic of many failure mechanisms. Forced-outage distributions have the same shape.

Distribution (b) differs from an exponential in that it allows more short and more very long outages but few of moderate duration. It is called a Weibull distribution. Just as in forced-outage simulation, Monte Carlo random draws are used with these distributions to determine for each unit the days to next repair need and the scheduled outage duration once it begins.

Once the need for repair occurs on a unit, the unit may continue operating temporarily. A list is kept of units in this condition, and units scheduled out are taken from this list by decision rules built into the model. These rules are simulations of human decision rules used by system operators.

History shows that scheduled outages almost always start on the weekend to take advantage of the low-load period. On the other hand, when a unit is forced out for one reason while due scheduled repair for another reason, many times both items are repaired during the same outage. However, if capacity is short and if the scheduled repair due is lengthy, the scheduled outage may continue to be delayed. Ability to recognize situations like these is built into the model.

Scheduled repairs always start in the model on simulated Friday nights unless they accompany forced outages. Units are taken out only if the reserve margin is adequate. Fig. 2 illustrates how megawatt capacity available for maintenance is computed. All factors in the computation are available from the load model or from other parts of the capacity model. In general, units due repair are taken out in order of size, largest first, up to the allowable limit. Units still due are postponed to following weekends.

While Fig. 2 illustrates one way to handle the human-decision part of scheduling outages, it is not the only way. Construction of a maintenance model can be designed to fit practices of the utility system being simulated. In addition, various changes in practice may be simulated. Results may be used to arrive at optimal scheduling procedures from a reserve viewpoint.

Simulation Of Periodic Overhaul

The capacity model recognizes periodic overhaul outages in addition to scheduled outages. On some systems every steam unit must receive a periodic overhaul outage to comply with a state requirement for a boiler inspection on a regular calendar basis. Sometimes other routine maintenance is performed while the unit is down, and these

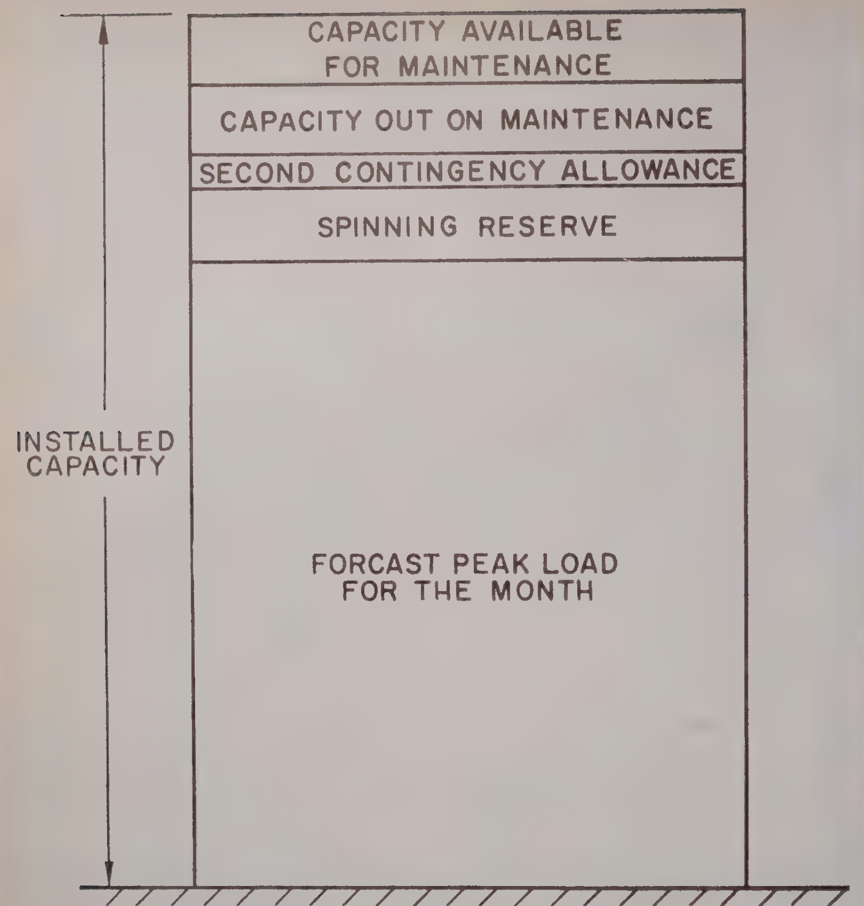


Fig. 2—Allotment of installed capacity to provide for load, reserve, and maintenance.

outages can last two to three weeks. These may be simulated on whatever basis they occur.

Suppose a periodic overhaul is required yearly and enough other maintenance is reserved for this outage to make it normally of three-week duration. The model keeps a record of each unit requiring such an outage and the number of weeks until the next outage on each unit is due. The weeks are so arranged that only one outage per year per unit is planned. A plan for the first year is furnished as input at beginning of the study. New plans for succeeding years are constructed by the model. In general, weeks to next outage are specified so that most outages are planned in the first nine months of the year and the peak month of June is avoided. See Fig. 3(a). Just when overhaul of an individual unit is planned depends on when its last one was taken. Periodic overhauls are always separated by at least nine months, and two are not performed on a unit within the same calendar year.

Periodic overhauls are rarely taken on the date first planned in actual system operation. Since this fact is simulated in the model, the model's tentative plan like Fig. 3(a) need not be too carefully made. Other logic decides exactly when the periodic overhaul is taken. Once a unit's periodic overhaul becomes due, it is listed in a separate tabulation. Removal of the unit from service is accomplished by logic similar to that used to take scheduled outages.

Removing Units From Service

Decision logic for removing units in the model from service is patterned after that used in actuality. Fig. 2 shows how total installed capacity may be allotted to load and reserve to carry forecast peak load with normal spinning reserve. Also a two-percent contingency reserve is provided. Remainder of installed capacity is available for scheduled outage and periodic overhaul. This maintenance allotment represents a prudent upper limit on the amount of unavailable capacity that should be permitted.

Each simulated Friday-night capacity already on outage (including the week's postponed forced outages) is subtracted from current maintenance allotment. Result is the permissible additional capacity which may be removed safely from service.

On any Friday night a number of units may be awaiting scheduled or overhaul outages. Units are removed from service until total capacity removed is just under the permissible limit. Early in the year, until October 1, scheduled outages are taken in preference to periodic overhauls. After October 1 the priority is reversed since all overhaul outages must be complete by year end. In fact, should any unit's periodic overhaul be planned later than October 1, it is nevertheless taken as soon after October 1 as load permits to avoid the heavier winter load periods and to assure its completion.

Should a scheduled and periodic overhaul outage both be due, they are taken at the same time. Also, whenever a forced outage occurs, weekend or not, scheduled and overhaul outages may be taken if they are due and ample reserve capacity is available. All of these tests are made in the model.

Durations of scheduled outages are random and are determined by appropriate distributions such as the one in Fig. 1(b). Duration depends on nature of the work to be done. Periodic overhaul durations are normally planned for three weeks. Should the reserve situation be marginal, because of excessive forced outages, the model provides for shortening periodic overhaul outages to two weeks. In fact, if inadequate installed capacity has forced postponement of the overhaul to the year end, the required boiler inspection may be accomplished in two days over a weekend. The model provides for this, too.

Figure 3(b) shows a revised pattern of periodic overhauls as simulated for 1961. The model's orig-

inal plan for that year is shown in Fig. 3(a). Considerable postponement and shortening of the outages is evident. One is accomplished the last weekend in the year. Some are combined with forced and scheduled outages. For illustrative purposes, this chart was produced by allowing load growth for two years with no new units added. It illustrates the ability of the model to handle even abnormal situations.

Economy Outages

Economy outages usually involve the most inefficient units on the system. Since these units remain on cold standby, their economic shutdown does not affect available margin. They are available for service if need be. On the other hand, just which units are on economy outage needs to be known. It affects their exposure to forced outage and scheduled repair need (Fig. 1 plots *operating* days to next outage), and it affects the spinning reserve realized.

The model simulates economy outages by starting up just enough units each day to meet the day's forecast load plus spinning reserve. The model could be expanded to include extra units run for economy interchange if importance of this aspect justifies the complication.

In general, units are started in a priority sequence supplied as input data. This sequence is based on efficiencies, area requirements, or other considerations as necessary. Naturally, units on outage are not counted in the startup of sufficient capacity to meet a day's needs. A running tally of days operated is kept for each unit and is used subsequently to obtain monthly production cost for the simulated chain of events.

Key To Understanding And Accuracy

The generating capacity model, in all its detail, is used with the load model to simulate reserve margins. Because of accurate representation of capacity, model has the ability to reveal the intimate connection between maintenance scheduling and system reserve situation. Adjustment of schedules to better reserve margins may be investigated.

Construction and experimentation with system load and capacity models provide a new and searching analysis of operating procedures. This comes as the model logic is formulated and as the mathematics of statistics is applied to power system data in new ways. The result is not only a model with which to study reserve margin but also a better understanding of system performance.

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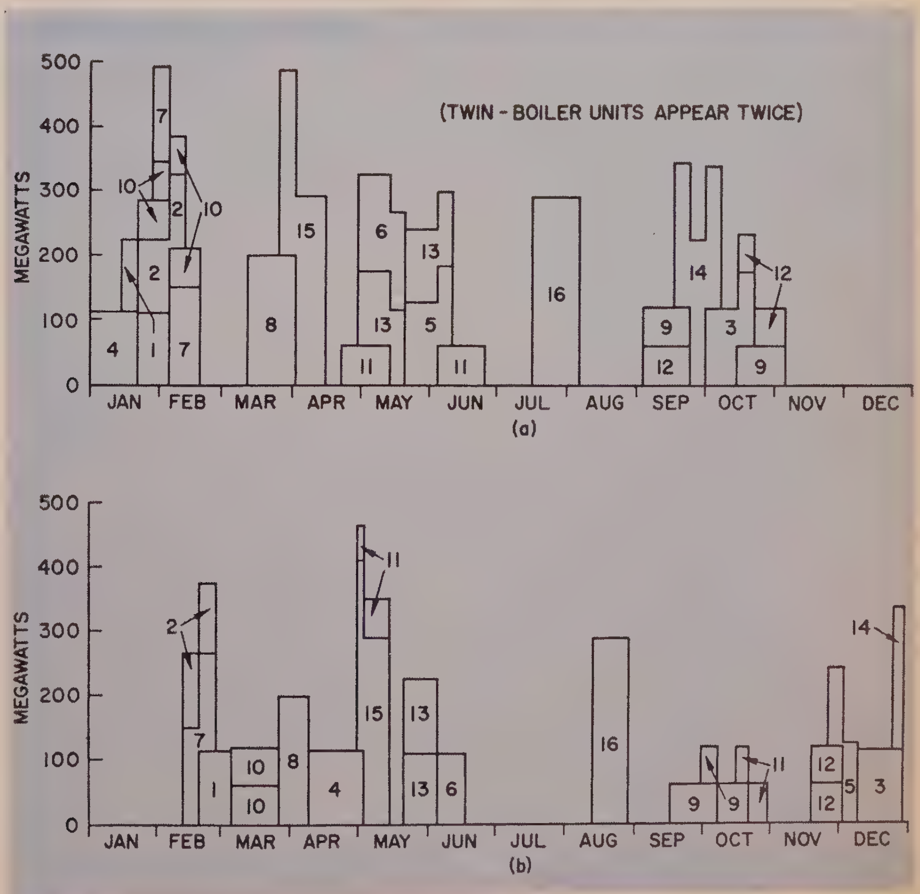


Fig. 3—(a) Periodic overhauls planned by model logic for 1961 with no new units added. (b) Periodic overhauls taken in 1961 with postponement, shortening, and outage combinations caused by inadequate capacity.

Fig. 4—Laboratory technicians make final tests on new equipment.

SILICON RECTIFIERS SUPPLEMENT D-C NETWORK LOAD

By CHARLES W. SMITH, JR.
Assistant Division Head, Technical Service Division, Transmission and Distribution Department, Boston Edison Company

Annual operating and maintenance savings gained in station shutdowns, plus salvage credits, approximate costs of rectifier installations; operating experience and studies indicate future units may be connected to secondary network, eliminating need for separate power transformers.

BOSTON EDISON'S three-wire d-c network, concentrated in the downtown Boston area and adjacent sections, carried a December 1958 peak load of 31,912 kw to 13,191 d-c meters. This load was supplied by eight substations operating rotating equipment, and 12 silicon rectifiers installed during 1957 and 1958. The latter units supplied approximately 1600 kw of this load, and their application was proving successful both from economic and operating viewpoints.

While most of the load growth in the area after the early 1930's was met by installation of an a-c secondary network and 4160-volt radial feeders, the d-c network load continued to grow from its beginning in 1886 to a peak of 84,000 kw in 1946. However, a new company policy, established that year, restricted d-c growth to older buildings, starting the downward trend in d-c load to a 1958 level about 36 per cent of its highest peak.

Rectifier Installations

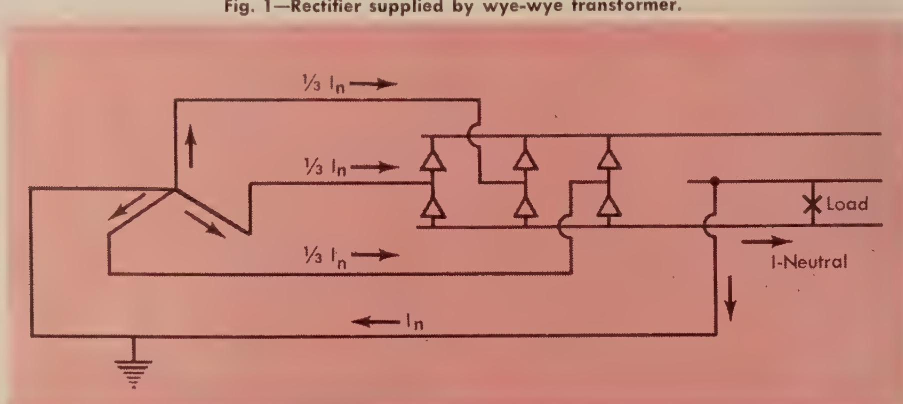
Ten of the 13 rectifiers presently in service are located in sidewalk vaults. These are oil-cooled, submersible units rated at 250 kw. Each is supplied with three-wire, three-phase 120/208-volt a-c service from a 300-kva transformer connected to the 4160-volt primary system in the same vault. Fig. 1 illustrates the method of supplying the rectifier by a wye-wye transformer. Supply transformers are overhead type, modified by installation of wiping sleeves on the primary side.

All sidewalk vaults are equipped with a sump and sump pump to prevent possible flooding. To date, there has been no flooding or high water in any of the vaults.

Fig. 2 is a simplified electrical diagram of the rectifier installation. Connections to the 4160 volt side of the supply transformer are made with five-kv varnished cambric and lead cable from the circuit through a three-pole underground oil switch to the transformer primary. Transformer secondary is connected with rubber and lead cables directly to the input side of the rectifier. Rectifier output is 240-volt d-c with positive and negative legs.

Fig. 3 illustrates the schematic diagram of the rectifier. Each d-c leg is connected through an amptrap to a feeder cable which terminates in a junction box. Terminations are made through 700-ampere fuses to the junction box busses.

Fig. 1—Rectifier supplied by wye-wye transformer.



Editor's Note—This is the essential text of a paper prepared by the author for presentation before the October 1959 meeting of Edison Electric Institute's Transmission and Distribution Committee.

Amp-Traps

Amp-traps were installed in the output of the rectifier to reduce possibility of damaging rectifier diode units due to overload. In the first four vault installations output amp-traps were rated at 1000 amperes. Subsequent installations used 1200 ampere amp-traps, and all replacements will be made with 1200 ampere amp-traps. The a-c end is arranged in a three-phase bridge circuit with five fused parallel paths for each phase, or a total of 15 400-ampere amp-traps. Fig. 4 shows these individual amp-traps, accessible in a compartment on the side of the rectifier, which serve to isolate a defective diode path in the event of a diode failure.

Economics

The first group of four oil-cooled rectifiers in sidewalk vaults was installed between August and November of 1957 in the "North End" area of Boston. Installation of these units resulted in discontinuing rotating equipment at the company's Salem Street substation. Estimated cost, including street work, was about two and one-half times annual operating savings which could be gained by shutting down the substation.

The next installation was a single oil-cooled rectifier in a customer vault in South Boston. This customer had previously purchased a-c power and by operation of a converter was engaged in resale of d-c power to his tenants. An order by the Massachusetts Department of Public Utilities discontinuing resale practice led to installation of the rectifier to supply d-c service to the building. This rectifier was tied in parallel to the d-c network in the street.

In September 1958, two oil-cooled rectifiers were installed in sidewalk vaults in the "West End" area of Boston, resulting in shutdown of rotating machines at the Cambridge Street substation. Plant investment and installation costs, less credit for eliminating station work which otherwise would have been required, and less salvage credits, approximately equalled annual operating and maintenance savings which could be gained in a shutdown of this substation. This made the installation very desirable from both economic and operating viewpoints.

In December 1958, four oil-cooled units were installed in sidewalk vaults in Boston's "South End" area, with resulting shutdown of the West Canton Street substation. Peak load in this area was approximately 1200 kw, tending to decrease about 10 per cent annually. Plant investment and installation costs, less credit for eliminating station work which would otherwise be required, and less salvage credits, equalled approximately 1.2 times annual operating and maintenance savings realized in a shutdown of the substation. Again, since operating conditions would be satisfactory, it was economically desirable to proceed with the rectifier installations.

Two more rectifiers are installed in a building in the Roxbury district. Here, a customer shut down his motor generator set in favor of purchased d-c power. Since some d-c service was required, a 300 kw air-cooled silicon rectifier was installed on the customer's premises in July 1958; it was not feasible to extend long feeders from the d-c network to supply the service. Some undesirable operating conditions resulted (these are described below), and in April 1959 a 250-kw oil-cooled rectifier was installed in parallel with the existing air-cooled unit. Changes eliminated temporary difficulties and operating experience has been very satisfactory.

Operating Experience

In 178 rectifier-months of operation, four blown fuses and seven blown output amp-traps have been experienced. Operation of the single rectifier in the Roxbury district involved problems at first because sudden load or short circuits on the customer's system would cause protective breakers on the rectifier to open before the customer's breaker would open. Since the protective breaker was at maximum setting, it was difficult to coordinate the setting with that of the customer's breaker. Temporary installation of the second rectifier and re-fusing branch circuits to proper values effected a satisfactory solution. (The customer intends to convert a large segment of load to a-c in the near future.)

Of the 11 blown amp-traps or fuses, eight were associated with a localized system trouble. Four blown fuses or amp-traps occurred when a system fluctuation caused loss of rotating machines at stations. Four occurred due to short circuits on the d-c system in the vicinity of rectifiers, and three blown amp-traps occurred for un-

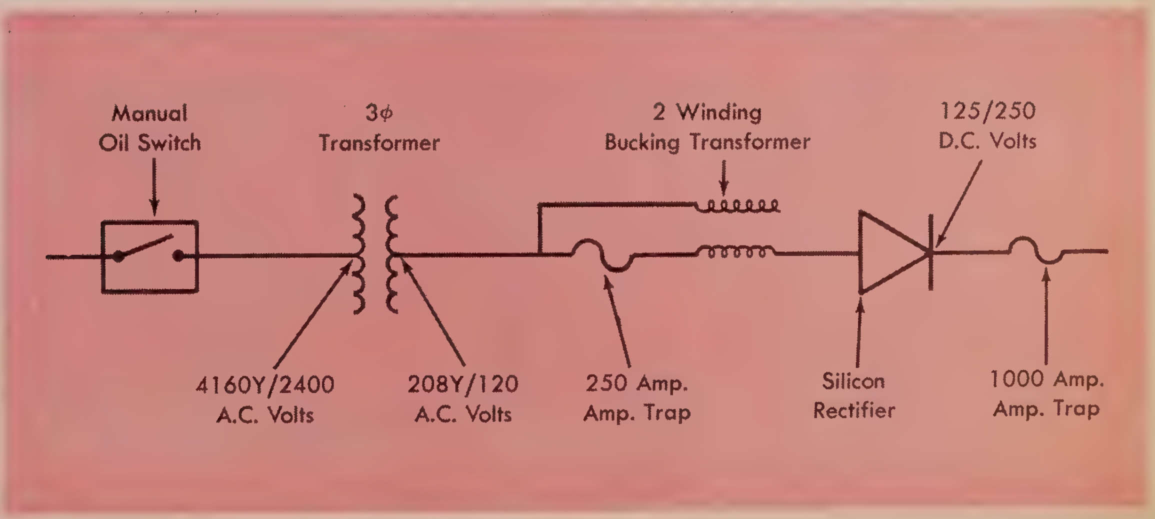


Fig. 2—Simplified electrical diagram of silicon rectifier installation.

determined reasons since no trouble could be found.

There have been outages on the 4160 volt radial feeders which have resulted in a loss of output from some rectifiers. None of these a-c troubles, or any of the blown fuses or amp-traps on rectifiers operating in parallel with the d-c network, has resulted in low voltage or loss of d-c service.

Energizing and Testing Rectifiers

For the installation of a rectifier, a step by step procedure has been prepared to identify in sequence each step and test to be made in energizing a rectifier and tying it into the system. After energizing, more checks are made to ensure satisfactory operation. These are as follows:

1. Take clamp-on ammeter readings of each of the 400-amp amp-traps hourly for several hours.
2. Simultaneously with ammeter readings, take indicating instrument readings of the current in each a-c input lead to the rectifier. If rectifier appears to be delivering too much load, or too little, to the network, the unit is de-energized and transformer taps are changed to obtain satisfactory loading.
3. Install one recording thermometer on rectifier tank at top oil level, and another on the vault wall between rectifier and supply transformer to measure ambient temperature. If temperature is normal after 24 hours, these instruments are removed.

Load readings are taken for an eight-week period as follows:

1. A-c input voltage and currents to the rectifier are read daily for two weeks, twice weekly for the third and fourth weeks, and once weekly for the fifth through the eighth week.
2. Current readings in each of the five a-c paths in each phase are taken once weekly for eight weeks.
3. Maximeters are installed on the a-c input to rectifier, and readings are reported weekly for eight weeks.

Operating Procedure

Since the d-c load in the "South End" area was to be served by the installation of rectifiers, and since support for this area via feeders from other stations would be very limited, a study was made to determine the possibility of losing d-c service to this area, and to determine how restoration would be effected. A procedure was developed to restore the area should there be a shutdown. The study indicated that one rectifier could pick up the area load between 12:01 A.M. and 6:00 A.M.; three rectifiers were needed between 6:00 A.M. and 7:00 P.M., and two were needed from 7:00 P.M. to 12:01 A.M.

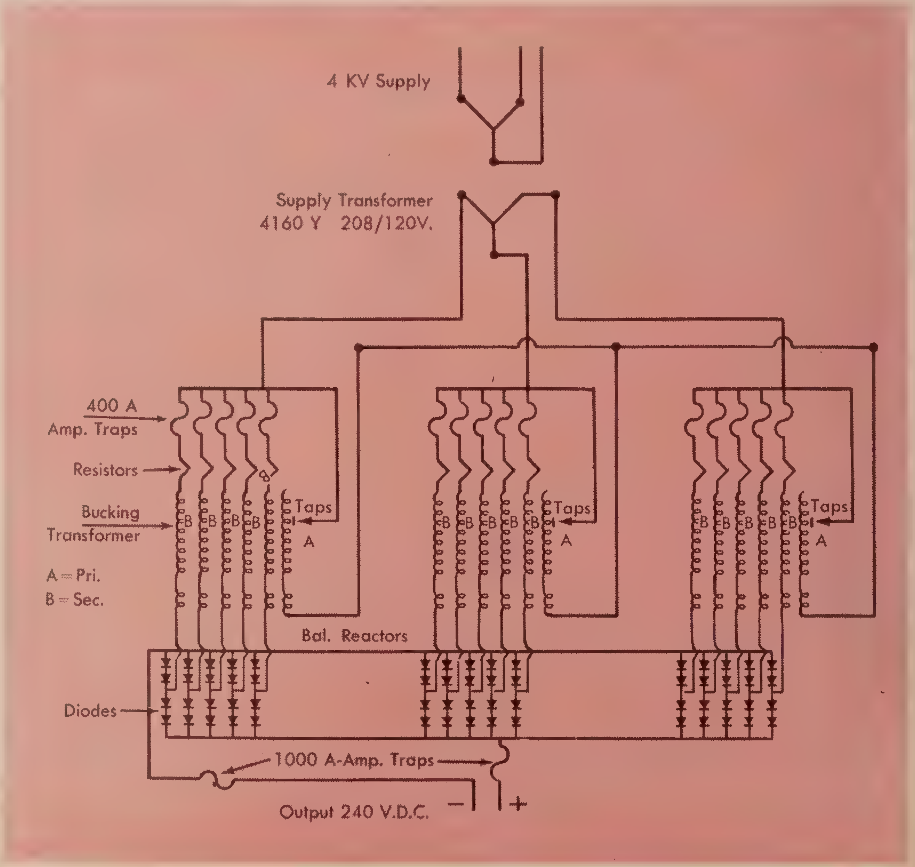
On a single contingency basis, the greatest hazard to continuity of d-c service in the area is the possibility of a 4160 volt a-c bus short circuit between 6:00 A.M. and 7:00 P.M. in the bus section where two of the four-kv circuits with rectifiers originate. The simultaneous loss of two rectifiers between the hours of 6:00 A.M. and 7:00 P.M. would cause the protective amp-traps on the other rectifiers and fuses to other sections of the network to blow, and the area would be de-energized. Since the substation supplying these circuits is a modern steel clad unit, the possibility of a bus short circuit is remote, but must be provided for. On the other hand, loss of a single four-kv circuit with its rectifier would not result in the loss of service or the blowing of fuses or amp-traps. Furthermore, while the remote possibility of losing all four circuits into the area would result in de-energizing the area, the rectifier amp-traps would not blow, and the d-c system would be re-energized when the four circuits were restarted, provided the restarting of three of the circuits was simultaneous.

In the case of a bus short circuit, the restoration would be effected by first opening the oil switches to isolate the two rectifiers supplied by the faulted bus. The a-c load supplied by the faulted bus would be transferred to other circuits through street tie switches. One of the two rectifiers which had blown its fuses, and which has the a-c supply from another bus in the same station where the bus fault occurred, would be isolated and the fuses and amp-traps replaced.

The non-faulted station bus section would then be killed briefly by opening the breakers to that bus section. The three isolated rectifiers would be connected to three of the four dead a-c circuits by closing

(Continued on page 86)

Fig. 3—Schematic diagram of 250-kw silicon rectifier.



Five-Years Experience With SECONDARY CAPACITORS in Series With DISTRIBUTION TRANSFORMERS

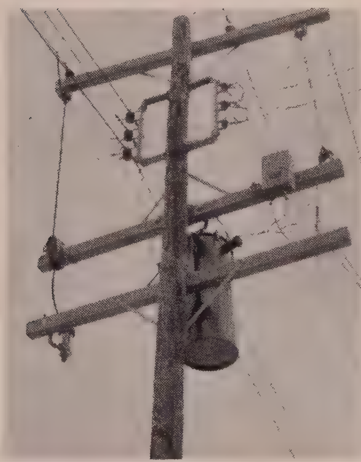


Fig. 3—Typical installation of 4-ckva capacitor with 25-kva transformer.

By FRED C. CROWELL
Load and Voltage Control Supervisor, Tulsa Area, Public Service Company of Oklahoma

Installations have been very satisfactory for improving voltage level and reducing or eliminating voltage flicker, greatest improvement occurring on fully loaded transformers serving poor power factor loads; some capacitor losses can be expected until all installations are protected by a suitable resetting protector.

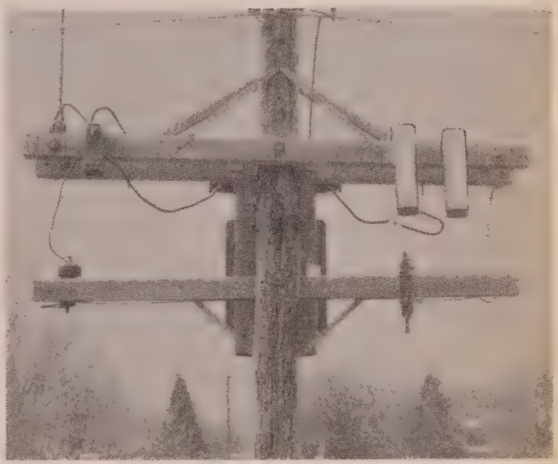


Fig. 4—Two 3-ckva capacitors in parallel in series with a 37½-kva transformer.

THE USE OF A CAPACITOR in series with a distribution transformer had not been practiced by any company to any extent when the first installation was made in the Tulsa distribution system in September 1953. Window type air conditioning and some of its associated difficulties were beginning to make an appearance. And, finding a quick method of solving poor voltage conditions, until engineering and line work could be done to permanently correct conditions, was desirable. Since early studies indicated feasibility of applying capacitors in this manner, and the first installation was made, Public Service Company of Oklahoma has gained 900,000 operating days of experience with this type of installation.

The first installation was a 240-volt three kvar capacitor in series with the primary bushing of a 2400-120/240-volt 15-kva transformer on a 2.4/4.1-kv multi-grounded wye system. The transformer served several houses having window-type air conditioners, one of which had four units. Both primary and secondary voltages were metered, and load on the transformer was also recorded by a graphic meter so that secondary voltage could be compared with primary voltage at various loads. Results were favorable and more installations were made.

The heat storm of 1954 brought a tremendous increase in air conditioning load and work during this summer involved much temporary voltage correction—putting out hot spots until proper and permanent solution could be made in the field. At this time we had an average of 150 series capacitor installations in service. These, installed by a two-man crew, provided the same temporary voltage correction that would have resulted from work of five or six heavy line crews changing out secondaries, primaries, and transformers, it has been estimated.

Shunt and Series Capacitors

It might be well at this point to recall the fundamental differences between shunt and series capacitors. A shunt capacitor is a current device. Its addition will lessen amperage on a poor power factor circuit by improving power factor, thereby reducing reactive current and improving voltage because of less line current. Current supplied by a shunt capacitor remains fairly constant. The series capacitor, on the other hand, is a voltage device. Adding it to a circuit changes power factor only slightly but current flowing through it can raise voltage much more than could a shunt capacitor of the same size. Voltage on the series capacitor varies directly with amperes flowing through it.

Applications

The combination of capacitors and transformers used in 1954 were: 3/10 (a three-ckva 240-volt capacitor in series with a 10-kva, 2400-volt transformer) 3/15, 3/25, 2-3/25, 2-3/37½, 2-3/50. (2-3/37½ means 2-3 ckva capacitors in parallel in series with a 37½ kva transformer.) By the summer of 1955, a four ckva 240-volt capacitor was being made expressly for our use. Combinations of a four ckva capacitor in series with a 25-kva transformer and 2-4/50 were desired combinations, and a good many three-ckva capacitors were replaced with four-ckva capacitors for better results.

Replacing a three-ckva with a four-ckva capacitor changes reactance compensation from 8.33 to 6.25 percent. This has the advantage of allowing the transformer to have a load 60 percent above rated load before the capacitor becomes fully loaded. The capacitor is fully loaded when the transformer is only 20 percent overloaded when a three-ckva capacitor is in series with a 25-kva transformer. Thus, three-ckva capacitors applied in 1954 to 25-kva transformers (which were 35 or 40 percent overloaded) were as much as

50 percent overloaded when initially placed in series.

A compensation of five percent, as is the case of a 3/15 combination, will allow a greater overload on the transformer before the capacitor becomes loaded; however, less voltage improvement results from like power factor loads.

At the present time, the following combinations are the main working forces on the system: 3/15, 4/25, 2-3/37½, 2-4/50. In addition, there are single installations of 3-4/75 on a 2.4-kv transformer station and a 4/25 on a 7620-volt transformer station. The capacitor in the latter installation is rated four ckva 720-volts.

It has been the company's practice to install capacitors in series with lighting transformers only. This includes lighting transformers on open delta lighting and power banks. No installations have been attempted on strictly power banks or on power transformers in an open delta bank, nor are any contemplated.

The practice followed for actual field installation is as follows: Since primary distribution is 2400/4160-volt multi-grounded wye system, capacitors are installed in series with the primary winding of the transformer between primary neutral bushing and the ground wire on the pole. A protective device is connected across the terminals of the capacitor as shown in Fig. 1.

It should be pointed out that the capacitor normally has a voltage across it which varies according to the load on the transformer. For instance, a four ckva capacitor in series with a 25-kva transformer will have a voltage across its terminals of about 148-volts at 100 percent of rated load. This voltage increases to 240-volts when the transformer is 60 percent overloaded. Therefore, extra caution must be exercised when working on a transformer station on which a series capacitor is located.

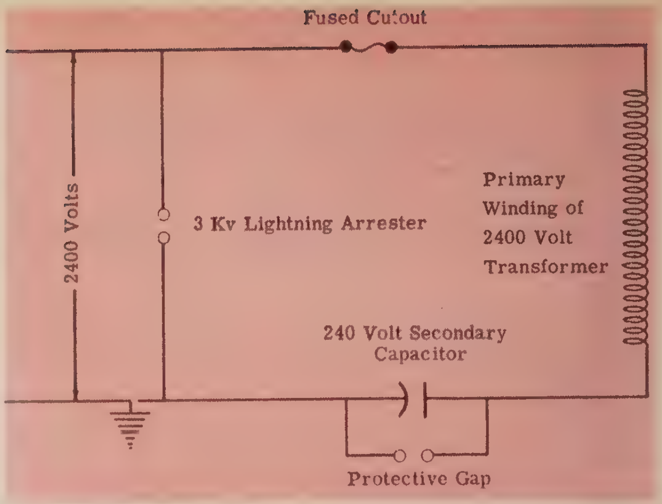


Fig. 1—Capacitors are installed in series with primary winding of transformer between primary neutral bushing and ground wire on pole. Protector is connected across capacitor terminals.

Protective Devices

Protective devices now used are the same as when we started. Early installations were not protected at all and capacitor unit losses were high. Protectors for use with capacitors in series with distribution transformers were not available.

One series capacitor protector rated 50 amp 5.2-kva was on the market and was purchased for use where there are two capacitors in parallel in series with a 37½ or 50-kva transformer. This is connected in parallel with capacitors and consists of a 900-volt gap link which normally restrains a spring loaded shorting contact. When the voltage becomes sufficiently high the voltage gap link blows apart and allows the shorting contact to short the capacitor out of the circuit. The capacitor is out of service, then, until the installation is checked and the gap link replaced. The method seems to function as well as could be expected for this type of protector. Used on stations having two capacitors, it lessens the possibility of having only one capacitor in the circuit after a protective device operation, should one capacitor fail during the operation.

The first protective device employed to cut down losses was a railway signal arrester rated at 240-volts. It consists of a thyrite disc in series with a gap and has a 60-cycle breakdown of 1000-1200-volts. It provides a substantial amount of protection for 240-volt capacitors but, here again, results are not as good as desired. These units, incidentally, cost about $2.50.

Many more damaged gaps than failed capacitors have been found, indicating that this device affords some degree of protection. However, the one-shot action is a major shortcoming, leaving the capacitor without protection until a periodically scheduled field check sometime later discloses and corrects the deficiency.

Fig. 2 — Capacitor loss frequency rate is the number of capacitors that fail in a period of 100,000 operating days.

New Protectors

There is one protector now on the market that appears to have nearly all of the features desired. Three years of testing one of these devices indicates that it breaks down at about 400-volts, resets automatically and is ruggedly built. However, its cost, to date, has been so high that, in our opinion, it cannot be economically justified. Field test results on another protector not yet on the market are inconclusive, but apparently protection afforded is good.

An early October field check of the installations using the latter two protective devices indicated all had had operations. Both devices and capacitors were found to be working and in good

condition. These devices are located in stations on which at least two capacitors had failed previously.

Early Failures

Some early failures were caused by line crews working on the distribution system. Closing the cutout on a transformer station having a series capacitor on it or returning a lateral to service on which series capacitors are located sometimes caused the protective gap to operate, often with a loud bang. This was caused by inrush current on a lightly loaded transformer. Thus, to prevent operation of the protective devices and keep possible capacitor losses to a minimum, line crews were instructed to short capacitors out of the circuit until line work was completed and the line placed back in service.

This condition is known as ferroresonance and is of extremely short duration. While possibility of damage to customer equipment is present, there have been no cases of known damage to customer's equipment. It does not seem to be an operating problem.

Line crews are also instructed to short out the capacitor in series at anytime the transformer is to be in parallel with another. On one occasion a portable transformer was placed in parallel with an overloaded transformer which had a capacitor in series with it. A load check revealed that both transformers were overloaded, and only after the capacitor was shorted out did the emergency transformer provide any relief for the overloaded unit.

Failure Rates

Effectiveness of protective devices is indicated by capacitor failures experienced over an extended period of time. Annual percent loss seems to have stabilized at about nine percent, which is not bad considering the method of protection so far employed.

In order to provide an effective basis for comparison of capacitor unit losses for the different time intervals between field checks and the different number of capacitors in service, a loss frequency rate was established. This rate, in turn, is converted to an annual loss percentage by means of the curve shown in Fig. 2.

The loss frequency rate is the number of capacitors that fail in a period of 100,000 operating days. The first time interval checked was a seven-month period having a loss frequency rate of 57.1, or slightly less than a 21-percent annual loss. This is due in part to the fact that some early installations had no protection at all.

Summary of Capacitor Failure and Gap Operations
Tulsa District, March 1, 1954 to June 1, 1959

TIME INTERVAL	AVERAGE NO. OF CAPACITORS IN SERVICE	GAP OPERATIONS	CAPACITOR FAILURES	LOSS FREQUENCY RATE	RATE OF ANNUAL LOSSES, %
3/1/54 to 10/1/54	150	26	18	57.1*	20.75*
10/1/54 to 5/1/54	328	44	8	11.2	4.00
5/1/55 to 10/1/55	406	67	23	35.6	13.00
10/1/55 to 8/9/56	481	34	21	14.6	5.25
8/9/56 to 6/29/57	448	137	32	23.3	8.75
6/29/57 to 12/9/57	595	127	38	35.5	13.00
12/9/57 to 6/1/58	590	49	23	21.6	8.00
6/1/58 to 12/20/58	569	86	35	33.0	12.00
12/20/58 to 6/4/59	527	88	25	26.3	9.75

Average Annual Loss—9.25%

* Some early installations were not protected by a gap

Service interruptions caused by capacitor failures have numbered only five, or about one a year. Interruptions in these cases occurred when the insides of the capacitor were blown clear of the case causing an open circuit. Usually, however, capacitors short circuit themselves to their cases upon failing. This removes any benefit from the capacitor, but service to the customer is not interrupted.

Fewer than a dozen customer complaints have resulted from the condition known as sub-synchronous resonance which causes a rather rapid light flicker. Some cases resulted from approximately 100 percent overload of the transformer. Some occurred on stations where a three rather than four ckva capacitor was in series with a 25-kva transformer. In all cases, changing the transformer to a larger size and then installing capacitors of the proper size in series with the transformer eliminated the flicker.

Summary

Installations of secondary capacitors in series with distribution transformers for improving voltage level and reducing or eliminating voltage flicker has been very satisfactory. Voltage improvement obtained varies from one installation to the other since voltage increase is dependent upon transformer load as well as power factor of load being served. Poor power factor load causes a greater voltage increase than good power factor load, and a fully loaded transformer usually shows more voltage improvement than a lightly loaded one. Transformers with power factor loads around 94 percent or better show no voltage improvement at all with addition of capacitors in the circuit.

Probably the largest voltage increase was obtained when a four ckva capacitor was installed on a transformer station that had an old 25-kva transformer with larger-than-usual impedance. Voltage rise on a 240-volt base was 20-volts, or about eight percent, and the transformer was not overloaded. Most voltage rises experienced are in the four to five percent range.

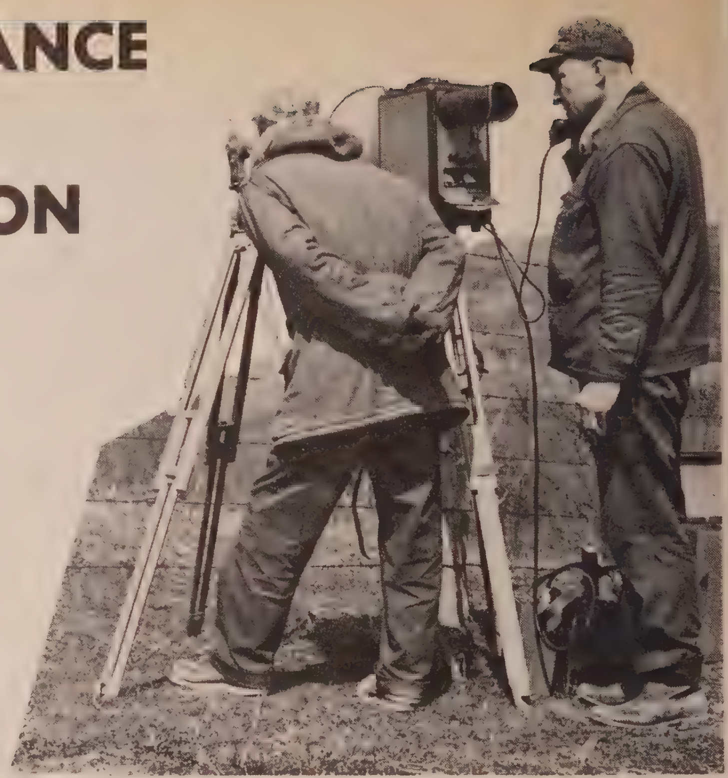
There have been no voltage problems as a result of using capacitors in series with transformers, and no damage to customer equipment has been reported. There have been only five service interruptions due to failure of series capacitors and less than a dozen flicker complaints.

Average annual loss has been 9.25 percent, which is not excessive considering types of protection used. Some capacitor losses can be expected until all installations are protected by a suitable resetting protector.

There have been no serious operating problems and benefits obtained by using capacitors in series with distribution transformers far outweigh difficulties experienced. While it is difficult to evaluate effect on customer relations in dollars and cents, certainly a prolonged bad voltage condition can greatly strain customer relations. Quick relief, on the other hand, can improve customer confidence and faith in the company.

MICROWAVE DISTANCE MEASUREMENTS SPEED TRANSMISSION SURVEYS

By M. J. Urner,
Manager,
Transmission and Distribution
The Potomac Edison Company



At the master (transmitter) station, Tellurometer operator (right) determines point-to-point distance by noting amount of phase shift between outgoing microwave pulse and pulse received from the remote unit. Communication between measurement points is by portable radio. Theodolite operator at left measures horizontal and vertical angles.

Potomac Edison makes first U. S. application of Tellurometer to improve established techniques for making aerial surveys for transmission lines.

FIRST USE in the United States of a remarkable new electronic surveying instrument, the Tellurometer, for transmission line surveying, occurred recently when it was used on the Potomac Edison System. Utilizing modern electronic theories and radar-like instruments, the Tellurometer can measure long distances with great accuracy in a matter of minutes.

Potomac Edison has used the technique of aerial photogrammetry for plan and profile surveying for nearly 350 miles of 132-kv transmission line constructed in the last eight years. While this method has been successful and has many advantages over on-the-ground surveying, one of the problems has always been the providing of precise control at reasonable cost so that the center line from the aerial survey can be finally run in its proper location on the ground.

When Air Survey Corp. of Arlington, Virginia, who have done most of Potomac Edison's aerial survey work, proposed the use of the Tellurometer for control in aerial surveying for a transmission line from Millville, West Virginia, to Frederick, Maryland, the idea was readily accepted. This 132-kv line, while only 26 miles long, starts with two miles in West Virginia including a crossing of the Shenandoah River, goes into Virginia for 10.5 miles, crosses the Potomac River and continues for the remaining distance of 13.5 miles in Maryland. Enroute it crosses several ranges of the Blue Ridge Mountains.

The project required the establishment of ten pairs of intervisible horizontal control points through the band to be mapped. Using the Tellurometer, a three-man survey party completed the job in ten days. Traditional chaining or triangulating methods would have taken a five-man party at least 30 days, it was estimated. Longest shot on the job was 103,440.15 ft (slightly more than 19½ miles).

Completely Portable

The Tellurometer was invented by T. L. Wadley, a scientist on the staff of the South African Council for Scientific and Industrial Research. It uses portable microwave equipment to measure the precise distance between two survey stations. A set of the equipment consists of two portable units, one a master set and the other a remote set, each powered by a six-volt automobile storage battery, with built-in radio telephones for communication. Accuracy is within plus or minus two tenths of one ft for any length measurement. The most effective range of measurement is from ½ mile to 40 miles. Cost of a set of the instruments is approximately $10,000.

The Tellurometer actually measures the time taken, in millimicroseconds, or billionths of a second, for a radio wave to travel from the master unit to the remote unit and return. With corrections for the small effect of variations in barometric pressure and humidity on the known velocity of radio waves, the time measurement can be converted into distance.

The electronic principles are simple. A continuous wave of about 10 cm in length—3,000 megacycles per second—is radiated from the master unit. This carrier wave is modulated by measuring frequencies of 10 mc and others of similar order and is received and re-

All the remote station engineer has to do to operate the Tellurometer receiver is flip switches. The receiver is almost identical to the transmitter. It intercepts the transmitter pulse and re-transmits it to the transmitter point. (All photos courtesy Highway Information Services.)

radiated by the remote unit. The return wave is intercepted by the master unit and the phase shift between the outgoing and incoming modulations is indicated by a cathode-ray tube. This phase shift gives the measure of elapsed time and is indicated by a small break in a trace adjacent to a circular scale. Four measuring frequencies are used and the same scale serves for all. For the sake of simplicity, the velocity of propagation used in the computation is half the actual value, so that the distance is deduced directly.

In order to convert the Tellurometer measurements to horizontal distances it is necessary to know either differences in elevation or vertical angles. Elevations can be determined by use of precision altimeters. However, since it was necessary to measure horizontal angles anyway, Air Survey Corp. found it more economical on the Potomac Edison project to measure vertical angles, using the highly accurate Wild T-2 Theodolite. This requires a clear line of sight between stations and the use of target lights.

On projects where horizontal angles need not be measured, however, advantage can be taken of the ability of the Tellurometer to function successfully through weather and visibility conditions which would halt conventional visual methods of surveying. Vertical angles can be computed with sufficient accuracy in such instances from elevations obtained with precision altimeters.

One of the principal advantages of the Tellurometer procedure, as in aerial survey work, is that it can be done without the public becoming aware of the project. Instrument set-ups can frequently be made within the limits of public highways, for example. Since all transmission line engineering can be completed without setting foot on the landowners' property, knowledge of the project can be withheld until the right of way man makes his first contact. It is believed that this withholding of general knowledge of the course of a proposed transmission line greatly facilitates acquisition of right of way.

Remote station engineer talks across the miles being electronically chained as he adjusts the Theodolite signal light. The Tellurometer system can be used effectively up to 40 miles between measurement points.

Rear view of new power plant showing two 160,000-lb/hr semi-outdoor boilers; deaerating heaters are on low roof behind boilers.

NICARAGUA BUILDS UNIFIED POWER SYSTEM

By P. H. JERYAN
Chief Resident Engineer, The Kuljian Corporation

Central-American nation takes steps to overcome power shortage, raise economy abreast of neighbors; builds system to serve 75 per cent of population; sells new distribution facilities to towns in installments.

ONE OF THE MOST AUSPICIOUS EVENTS in the industrial development of a country, especially an underdeveloped country, is the inauguration of an organized electric power system. From the moment that dependable, reasonably-priced electrical energy becomes available a noticeable increase in standard of living is pretty certain to follow.

Nicaragua, small Central-American nation of 1,400,000 population and approximately 52,000 square miles of land, instituted such a program in 1954 when it engaged The Kuljian Corporation to study the country's urgent power needs and make recommendations within three months. Subsequently, Kuljian was assigned the design, engineering, procurement, supervision of construction and initial operation services for a power plant, expanded transmission and distribution systems—all on a turn-key contract.

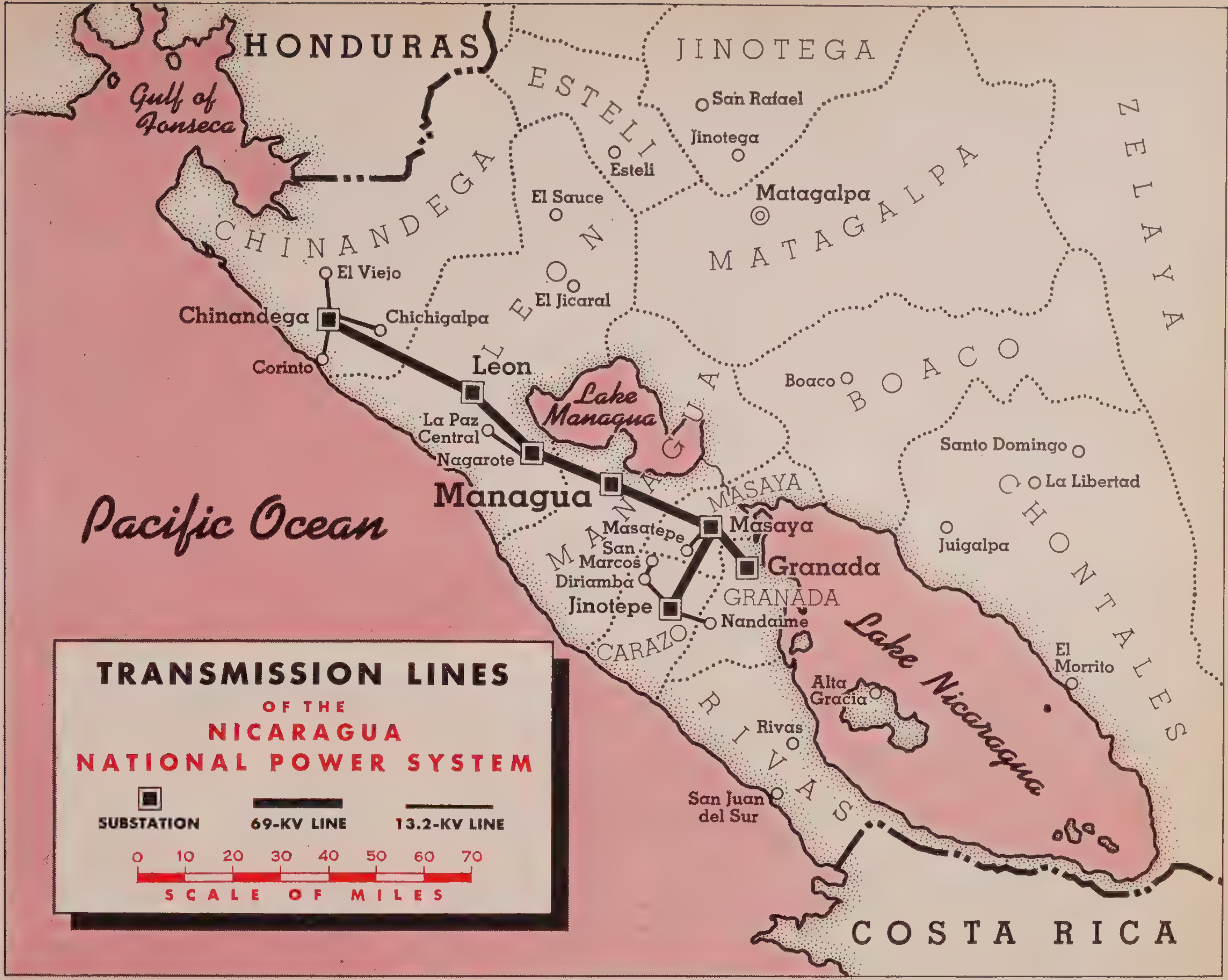
The Country

Nicaragua is situated between the Caribbean Sea and the Pacific Ocean, with coast lines of approximately 300 miles and 200 miles, respectively. Volcanic peaks and lesser mountain chains parallel the Pacific not far from the seacoast; in contrast, the Caribbean coast area is low and swampy.

Two great fresh-water lakes are situated near the Pacific coastline. They are Lake Nicaragua, 100 miles long and 40 miles wide, and Lake Managua, 40 miles long and 14 miles wide. Both lakes are near active and inactive volcanic peaks which with the lesser mountains provide fine highland valleys rich with agriculture.

The area between the two great lakes and the Pacific, much of western Nicaragua, was selected for

New 33,000-kw power plant in Managua is first thermal installation in the Republic of Nicaragua; it supplies power to that city and 14 other towns along 110-mile transmission line.



New Nicaragua transmission system showing location of substations.

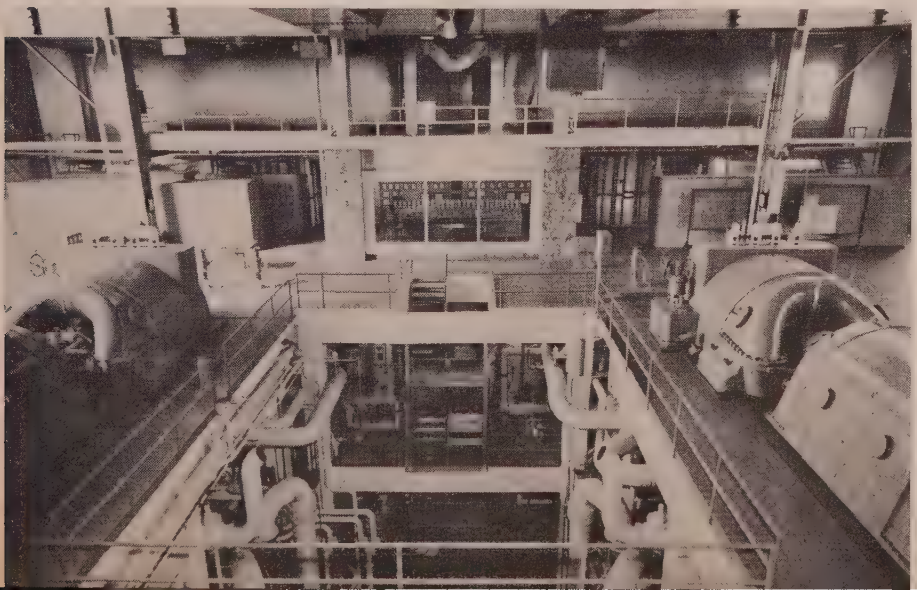
initial electrification. It contains approximately 75 per cent of the country's population and includes its four largest cities. Most of the industrial, commercial, educational, and governmental activities are located in this area.

Existing Facilities

When the project "Electrification of the Pacific Area" was begun, the capital city Managua was served by a generating plant having a total nameplate capacity of 10,160 kw. Eight diesel engines of varying vintage and states of repair provided about 9000 kw of dependable capacity.

Outside of Managua, in the 14 towns within the project area, total power generated for public consumption was only 4000 kw. Each town generated its own power with small, old, and poorly-maintained diesel units. In addition to the inadequate capacities, service in all towns was seriously limited by antiquated, improvised distribution facilities. In most cases, use of electrical appliances was very limited and voltage regulation was nonexistent. Lighting was the principal load in the smaller towns.

Power demand had always been greater than supply and rate structures offered no incentives. In Managua, loads larger than 25 hp could not be connected to the system without special arrangements with the electric company. This gave impetus to use of privately-operated plants which were expen-



Turbine room showing two 16,500-kw turbo-generators; air-conditioned control room, center background, features graphic panels for boilers, turbines, and generators.

sive in relation to output and were poorly manned and maintained. Solution to such conditions was the creation of one power network delivering unlimited power from a source of sufficient capacity.

New Facilities

Finalized plans included a 33,000-kw steam power plant, 110 miles of 69-kv transmission lines, seven substations, 57 miles of 13.2-kv feeder lines, and new distribution systems for Managua and each of the other 14 towns to be served.

The power plant was located in the eastern part of Managua by the shore of Lake Managua, immediately west of the existing diesel plant. This location makes it possible to serve the northern and southern sections of the project area. The site also affords convenient interconnection facilities with a proposed hydro-electric power project under study for a location approximately 60 miles from Managua.

Location of the new thermal power station has the additional features of: proximity to the existing diesel plant, enabling its output to be coordinated with the new facility; one management and operating force for both plants; large areas available for future expansion and oil storage tanks; unlimited fresh water supply from Lake Managua; and convenient railroad and highway facilities.

Towns fed by the transmission system are: Managua, Leon, Narrarote, Chinandega, Masaya, Granada, Jinotepe, El Vieho, Pa Pax Centro, Nindiri, Masatepe, San Marces, Diriamba, and Nandaime. Substations are located in each of the first seven of these towns. Telephone communications between the steam plant and substations is provided by a two-frequency duplex carrier-current system.

The 69-kv transmission lines use "H"-frame, flexible, hot-dipped galvanized steel towers fabricated in Austria. The 13.2-kv lines use single wood poles, of American production, seasoned and treated to specifications.

Special consideration had to be given to tower erection as a result of the country's topography and soil conditions. This necessitated clearing of jungle flora, constructing special tower footings in areas containing solid volcanic ash, and negotiating rough hills, ravines, and water crossings. Surveying, staking and erection work along the transmission line right-of-way were slowed during the six-month rainy season, which at times brought torrential tropical storms to the area.

Generating Station

Equipment specifications were based on American practice and standards. All equipment for the power plant, as well as transmission and distribution systems, was supplied by Siemens-Schuckertwerks of Germany. The boiler room equipment was obtained from the German Babcock & Wilcox Steam Boiler Works Ltd., of Oberhausen.

Power in the new steam plant is generated at 13,200 volts, three phase, 60 cycles by two 16,500-kw turbine-generator units. These units feed a 13.2-kv bus to which output of the old diesel plant is also connected through three 3750-kva, 2400/13,200-volt transformers. This 13,200-volt supply, which also feeds the Managua distribution system through a four-wire grounded network, is stepped up to 69 kv through a 15,000-kva, three-phase, oil-immersed transformer, to feed substations outside Managua along the 110 miles of transmission lines.

Each of the two semi-outdoor steam generating units delivers 160,000 lbs/hr of steam at a working pressure of 900 psig and total temperature of 910F at the superheater outlet. The combustion control system is electrically operated. The boiler can be operated either by automatic or semi-automatic control. Remote manual controls are provided for the entire regulation system, permitting boiler operation by hand at any time.

Bunker "C" fuel oil is used for combustion. This is delivered by tanker at the Port of Corinto, 70 miles north of Managua, and is transported by rail car or tank trucks to the two 600,000-gal stor-

(Continued on page 86)

Substation at Granada steps down power from 69 kv to 4.16 kv; low-voltage section is outdoor-type metalclad switchgear with draw-out circuit breakers.

HOW TO LEVEL TRANSFORMER SUPPORTS

By A. D. STOCKTON, JR.
System Station Dept.
Appalachian Power Co.

An improved method for leveling the steel I-beams used to support station transformers has been developed by the Appalachian Power Co. This method, which has been in use since 1957, accurately supports the beams during and after grouting. It also guarantees an even distribution of load through the grout and foundation—a difficult problem with the former practice.

Formerly, contractors were permitted to level transformer supporting beams for grouting by first running nuts down on all foundation anchor bolts, leaving top of nuts 1¼ in., 1½ in., or as specified, from concrete. The beams were then placed on these bolts and the nuts held the beam the required distance above the concrete. The beams were then leveled accurately by adjusting these nuts under the bottom flanges, until the top surfaces of the beams were all at the same level.

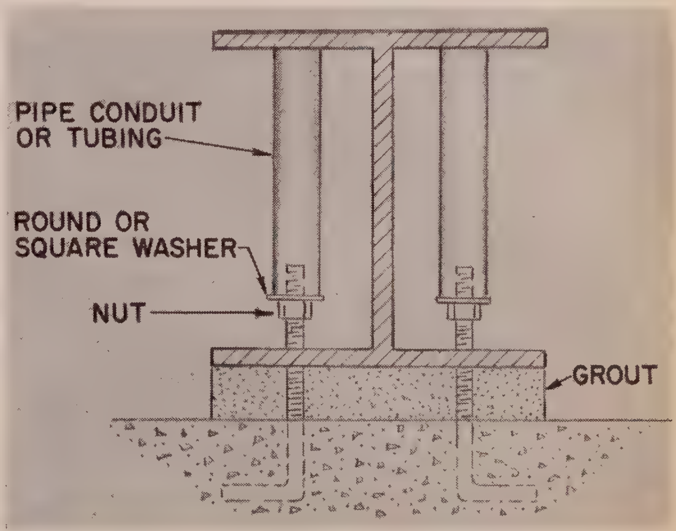
The grout was then placed and allowed to set up. After sufficient curing, an additional nut was placed on the anchor bolt and turned down on top of the bottom flange. The nuts under the flanges were left in place and never seen.

The new method can accomplish this same accurate leveling and provide a more even distribution of load by not using the nuts under the lower flange of the beam.

First, the nuts are removed from anchor bolts. The beam is then placed over the anchor bolts and allowed to rest on the foundation. Then the nuts are replaced over the anchor bolts and turned down part way.

Round or square washers are placed on top of these nuts and short uniform lengths of pipe, conduit or tubing are placed over the ends of the anchor bolts. The lower ends of these pipe sections rest on washers and the upper ends reach up and touch the underside of the top flange. (Be sure to use pipes with a large enough inside diameter to permit their removal without lifting the beam.) Then turn back the nuts until pipes lift the beam to the correct position. Bring the tops of all beams to the same level. Then place grout as shown, using AEP standard construction specification for mixing grout.

Allow the grout to set up. Then remove the short supporting pipes and the washers by turning the nuts part way down until the pipe can be lifted off. *Wait until grout has had sufficient time to set.* Then turn nuts down snugly against the bottom flange of beam.



I-beam supports for transformers or other equipment while grouting underneath. Top flange is supported by pipes and adjusting nuts. Former method of using nuts to support the bottom flange produced unequal distribution of load on grouted foundation.

TEST BLOCK SAVES TIME AND EQUIPMENT

By WILLIAM L. GRAHAM
Chief Electrician
Devon Generating Station
The Connecticut Light and Power Company

A test block developed for testing 2.3-kv motors and cables on auxiliary equipment at Connecticut Light & Power has greatly reduced testing time and provides all the safety features of a circuit breaker. With this equipment blocking off the live 2.3-kv couples, it is unnecessary to break and remake connections.

Formerly four to six men were required to spend a week in testing these motors and cables. And this former method was detrimental to motor leads and cables which were subject to much twisting and bending in breaking and remaking connections. Now only one man can complete the job in 1½ days and there is no necessity of breaking connections.

The test block was built so that it fits in place of the 2.3-kv air circuit breaker. It presents connections to which test equipment may be attached for simultaneous testing of motors and cables.

Originally the block, which is racked into position similar to circuit breakers, was used only on units which have manual elevating mechanisms. The addition of an adapter has now made it available for use on another which is a 4.16-kv unit and has an electrically-operated elevating system. The adapter fits the shutoff switch on the elevating mechanism and enables the block to go into position automatically and then shuts off.

The test block itself is made of micarta and is on a steel frame mounted on rollers so it may be wheeled easily from one unit to another. It measures 21 x 22 x 31 in. and weighs 25 lbs.

POWER STATION VULNERABILITY . . .

(Continued from page 68)

turning of an element, as in the case of a current limiting reactor, the resistance is the restoring moment due to gravity.

The term F(t) is simply the forcing function, which is furnished by the load prediction, and which was described above.

The problem then reduces to solution of a second-order differential equation where the resistance and forcing functions do not lend themselves, in general, to simple analytical expressions. For this reason most of the solutions were carried out by numerical methods; in only a few cases was it possible to obtain solutions in closed form.

Resistance Function

The resistance function for each structure was computed by analyzing its elastic properties up to the yield point, and calculating its deformation beyond this point up to rupture. Base connections, amount of concrete reinforcement, formation of plastic hinges, and the like played critical roles in determining the shapes and magnitude of these functions. Several typical resistance functions are shown in Fig. 3.

Damage Assessment

Extent of functional damage was estimated by reviewing with station personnel and manufacturers the physical damage calculated. Repair times were estimated on the basis that certain items were shelf items and could be procured readily, while others were "special" and consequently involved longer lead times. A summary of critical overpressures for the various items of electrical equipment and structures, and their associated repair or replacement times, is provided in Table I.

Predictions for these items were combined with those for mechanical items to determine which structures and equipment were critical to recovery of the station after nuclear attack. The results are collected in Table II. It should be noted that the 69-kv disconnecting switches were damaged, or failed, at low overpressures, and up to 10 psi constituted one of the most vulnerable items of equipment in the entire station. The failures were initiated by violent damage to the supporting steel structure.

Patterns of Recovery

Having developed estimates of repair and replacement times for individual items of equipment, it was possible to project patterns of recovery, or recuperability, for the entire station.

The predicted patterns of recovery are given in Fig. 4. Using this history of recovery, two principal conclusions may be drawn: (a) It will be noted that for nuclear attacks where the incident overpressure is 10 psi or less, recovery of the station can be effected to the 60 percent of rated output level or higher, in 24 weeks or less, and (b) attacks of 15 psi or more effectively reduce the station output to zero for at least a year and a half.

Acknowledgments

Technical work performed under this program involved many people. Contributors included E. V. Gallagher, R. W. Sauer, T. H. Schiffman, and the late E. J. Vlad.

SILICON RECTIFIERS . . .

(Continued from page 76)

selected switches at street locations. The fourth a-c circuit would be opened at the bus. Simultaneous closing of the bus supply breakers would pick up three a-c circuits and three rectifiers. The fourth a-c circuit would then be closed onto the bus. This would start all a-c and d-c load in the area.

In order to implement the above procedure, 14 major customers in the area would have their service switches opened to reduce the load by slightly more than 250 kw.

As an aid to the Distribution Dispatching Division, a map of the sections of Boston served by rectifiers has been color-coded to indicate zones where a short circuit or burn off of a d-c cable might cause an amp-trap to blow. In many areas more than one rectifier could be affected. Whenever a short circuit or burn off of the conductors occurs in a color-coded zone, a troubleman is dispatched to check the condition of the amp-traps, and to replace any blown one found. In addition, rectifier junction box fuses are checked.

The company has been very satisfied with operation of silicon rectifiers to date, and studies are underway at the present time for adding more rectifier units. These proposed units may be connected to the secondary network system, thus eliminating the need of a separate power transformer which has been used in each of the present installations. There is every indication that future operation will be as successful as past experience has established.

NICARAGUA BUILDS . . .

(Continued from page 84)

age tanks at the plant site. The oil is purchased in the foreign market.

Condenser circulating water is obtained from adjoining Lake Managua through four vertical mixed-flow pumps, two for each unit. Two submerged, reinforced concrete pipelines, 72-in. diameter, 1500 and 1700-ft long, serve as intake and discharge lines. At the lake-shore intake and discharge structure, where the two lines converge, provision is made for reversing flow in both lines to take care of possible lake currents. Station service water is obtained from a deep well.

The first 16,500-kw unit started commercial operation in July 1958 and the second similar unit went on the line in October of the same year. The 69-kv transmission lines and the 13.2-kv lines were placed in service in September 1958; these are gradually being followed by connections of the distribution systems of the 14 towns outside Managua. The distribution system of the capital city began operation in April 1959.

Loans for the entire project were secured from the International Bank for Reconstruction and Development (World Bank). The power plant, transmission lines with substations, and the Managua distribution system were built for Empresa Nacional de Luz y Fuerza. Power distribution work for the 14 towns in the project area was performed for Institute de Fomente Nacional. Both of these organizations are under government direction. Each town purchases its power from "Empresa" and pays "Institute" in installments for construction of its distribution system.

Hotpoint Forecasts 10-Year Appliance Sales Spree

Appliance dealers will be selling three appliances in the 60's for every two they sold in the 50's, according to market research experts at Hotpoint division of General Electric. They predict housewives are going to own almost 200-million major appliances in the next decade including some newly announced ones such as electric baseboard heating.

"Some 50-million consumers will spend $10-million every day for the next 10 years to purchase major appliances," says John F. McDaniel, general sales manager of Hotpoint. "Because of this expenditure, sales of the industry in the next decade will climb 42-percent," he added.

Mr. McDaniel said that one of the most interesting facts shown by the forecast is the annual industry sales rate.

In 1960, the forecast shows the annual rate will be 14.6-million appliances. By 1965 that rate will have climbed to 18.6-million. By 1969 that sales rate will rise to over 20-million units for a 63-percent increase for the 10-year period. Total sales for the 10-year period will be over 178-million units—better than three appliances per family.

According to Mr. McDaniel, the forecast does not take into consideration new appliances, as yet undeveloped or still in the laboratory stage.

Here are highlights of the 10-year forecast.

Free Standing Ranges

Industry sales of electric ranges will reach 950,000 in 1960. Most of these (96.8-percent) will be replacement sales. The number of cabinet ranges in use by the end of

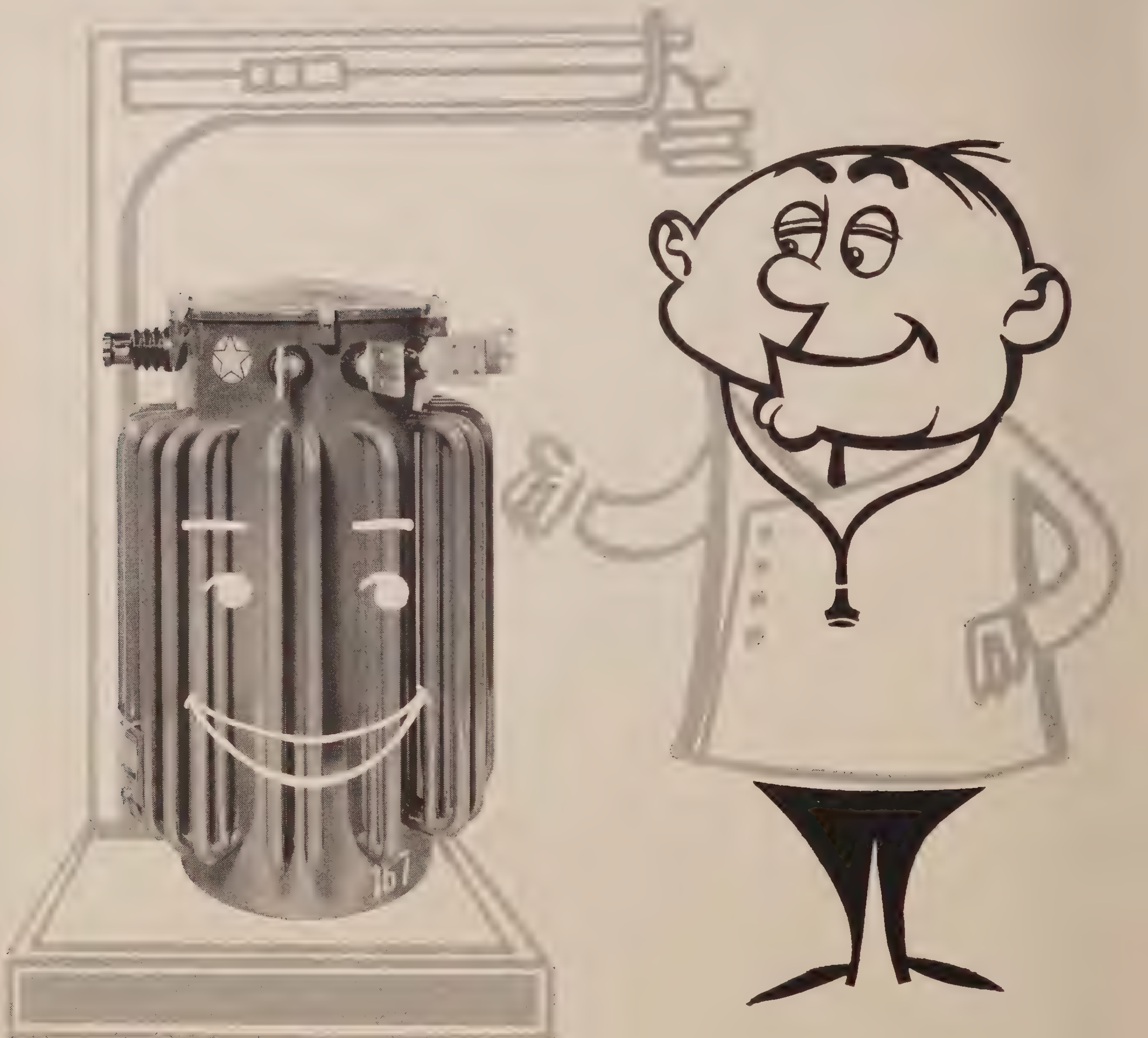
(Continued on page 97)

10-Year Forecast — By Appliance

APPLIANCE	YEAR	% SATURATION*	NO. IN USE	ADDED OWNERSHIP UNITS	ADDED OWNERSHIP %	REPLACEMENTS UNITS	REPLACEMENTS %	INDUSTRY SHIPMENTS
Electric Cabinet Ranges	1959	26.0	13,135	47	5.1	883	94.9	930
	1960	25.6	13,165	30	3.2	920	96.8	950
	1969	22.1	13,266	8	.7	1,092	99.3	1,100
Electric Custom Ranges	1959	5.4	2,742	734	97.9	16	2.1	750
	1960	6.8	3,523	781	97.6	19	2.4	800
	1969	19.4	11,658	877	77.6	253	22.4	1,130
Refrigerators	1959	99.2	50,192	1,285	36.5	2,235	63.5	3,750
	1960	99.6	51,292	1,100	31.2	2,425	68.8	3,800
	1969	100.0	60,100	1,100	21.5	4,025	78.5	5,400
Freezers	1959	22.3	11,276	942	80.0	236	20.0	1,200
	1960	23.6	12,156	880	76.5	270	23.5	1,200
	1969	31.5	18,916	750	53.6	650	46.4	1,450
Room Air Conditioners	1959	12.9	7,506	1,552	92.5	126	7.5	1,800
	1960	14.2	8,533	1,248	89.8	142	10.2	1,500
	1969	26.1	19,515	1,341	56.8	1,019	43.2	2,560
Dishwashers	1959	6.3	3,195	441	84.0	84	16.0	525
	1960	7.1	3,663	468	81.4	107	18.6	575
	1969	14.9	8,983	664	50.3	656	49.7	1,320
Disposers	1959	9.5	4,828	683	87.0	102	13.0	785
	1960	10.7	5,521	693	84.0	132	16.0	825
	1969	21.4	12,846	936	69.3	414	30.7	1,350
Electric Water Heaters	1959	18.7	9,470	94	12.7	646	87.3	740
	1960	18.5	9,528	58	7.8	692	92.2	750
	1969	16.2	9,724	4	.5	746	99.5	750
Automatic Washers	1959	41.7	21,094	1,884	62.5	1,131	37.5	3,015
	1960	44.6	22,969	1,875	58.7	1,320	41.3	3,195
	1969	55.5	33,335	708	17.6	3,312	82.4	4,020
Electric Dryers	1959	12.7	6,437	648	69.3	287	30.7	935
	1960	13.8	7,082	645	64.5	355	35.5	1,000
	1969	20.9	12,551	485	32.9	990	67.1	1,475

*Total Homes Wired: 1959 — 50,600; 1960 — 51,500; 1969 — 60,100

167-kva Featherweight Pole Star®
now weighs in at 1350 lbs.



More power per pound than ever before in a 167-kva distribution transformer

After having "weighed in" at approximately 1500 pounds when introduced in 1953, Pennsylvania's 167-kva Featherweight Pole Star Transformer has been steadily reducing . . . to 1425 pounds in 1956 . . . and now, all the way down to *1350 pounds*. This new low weight for a 167-kva transformer means easier handling, and easier, less costly installation.

In addition to the pounds and installation costs that it saves, the latest weight reduction is noteworthy in that it once again demonstrates the *continuous nature* of Pennsylvania's program of product improvement. The accomplishment of being the first manufacturer to break the "100-kva barrier" on pole mounting has been but one step in the search for ways and means of providing the nation's utilities with more power per pole. In addition to periodic weight reductions, the program has resulted in 250 and 333-kva Featherweights for pole or platform installation. The next step is a lightweight 500-kva transformer, for which preliminary designs already are in progress.

Featherweight Pole Star 167's are being used singly or in clusters at new shopping centers, in existing areas in which power needs have multiplied, and in other applications calling for the maximum power per pole. For information regarding the 167 and other Pole Star Featherweights—all available through 15 kv—contact Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pa.

PENNSYLVANIA DISTRIBUTION TRANSFORMERS

Hotpoint Forecasts . . . *(continued)*

1969 will be 13,266,000 resulting in a saturation of 22-percent based upon 60,100,000 wired homes.

Built-in Ovens—Surface Units

The phenominal growth of built-in ranges will continue on into the sixties. Industry sales for 1960 will reach 800,000 units and will go over the million mark by 1964. Saturation in 1960 is forecast at 6.8-percent and will almost triple during the next ten years reaching 19.4-percent by 1969.

Refrigerators

By the end of 1960, more than 51-million refrigerators will be in use representing a 99.6-percent saturated market. It will take a million refrigerators each year during the 60's just to supply the increase in wired homes.

Freezers

At the start of the sixties, over 11-million families own freezers and by 1969 nearly 19-million will own them. Saturation will reach 31½-percent by 1969.

Air Conditioners

The near record, 1,800,000 of air conditioners sold by manufacturers in 1959 is expected to be met but not exceeded in 1960. Only 10-percent of the air conditioners sold are replacement units today, but by 1969 this figure is expected to increase to 43-percent and volume will be well over the 2½-million level.

Water Heaters

Sales of water heaters are forecast for 1960 at 750,000 units and the expectations are that this level will be maintained throughout the decade. Replacement business that in 1960 will be 92-percent of the total will increase to over 99-percent by 1969.

Dishwashers

The forecast indicates that in 1960 the industry will sell 575,000 automatic electric dishwashers, of which 81.4-percent will be added ownership. By 1969, the number of dishwashers in use is expected to reach almost 10-million.

Food Waste Disposers

Food waste disposer sales in 1960 will total 825,000. By 1964, they will have gone over the million mark and by 1969 the rate will be 1,350,000.

Automatic Washers

Fighting for first place as the bell-cow of the industry with the refrigerator, automatic washer sales in 1960 will reach 3,195,000. By 1969, the industry will be selling over 4-million automatic washers a year of which 82-percent will be replacements and 18-percent added ownership.

Duncan Mobile Product Display Travels For Metermen

Information for utility men interested in meters is being made available by Duncan Electric Co., Inc. in a mobile way. A traveling product display on meters and mounting devices has been calling on utilities to give on-the-spot demonstrations of the latest developments in metering and to answer many questions regarding different types and classes of meters.

Within ten minutes after the

Duncan meter display wagon compactly tucks meter exhibits away in rear. Meters and mounting devices are located inside three separate cabinets, which easily slide in and out on tracks provided.

(Continued on page 101)

Duncan Road Show ***(continued)***

meter display wagon arrives, it has been converted to a product display that may be seen readily by small groups up to 25. A complete array of modern meters and mounting devices is housed in three custom-built cabinets, and can be shown in almost any location, either indoors or outdoors.

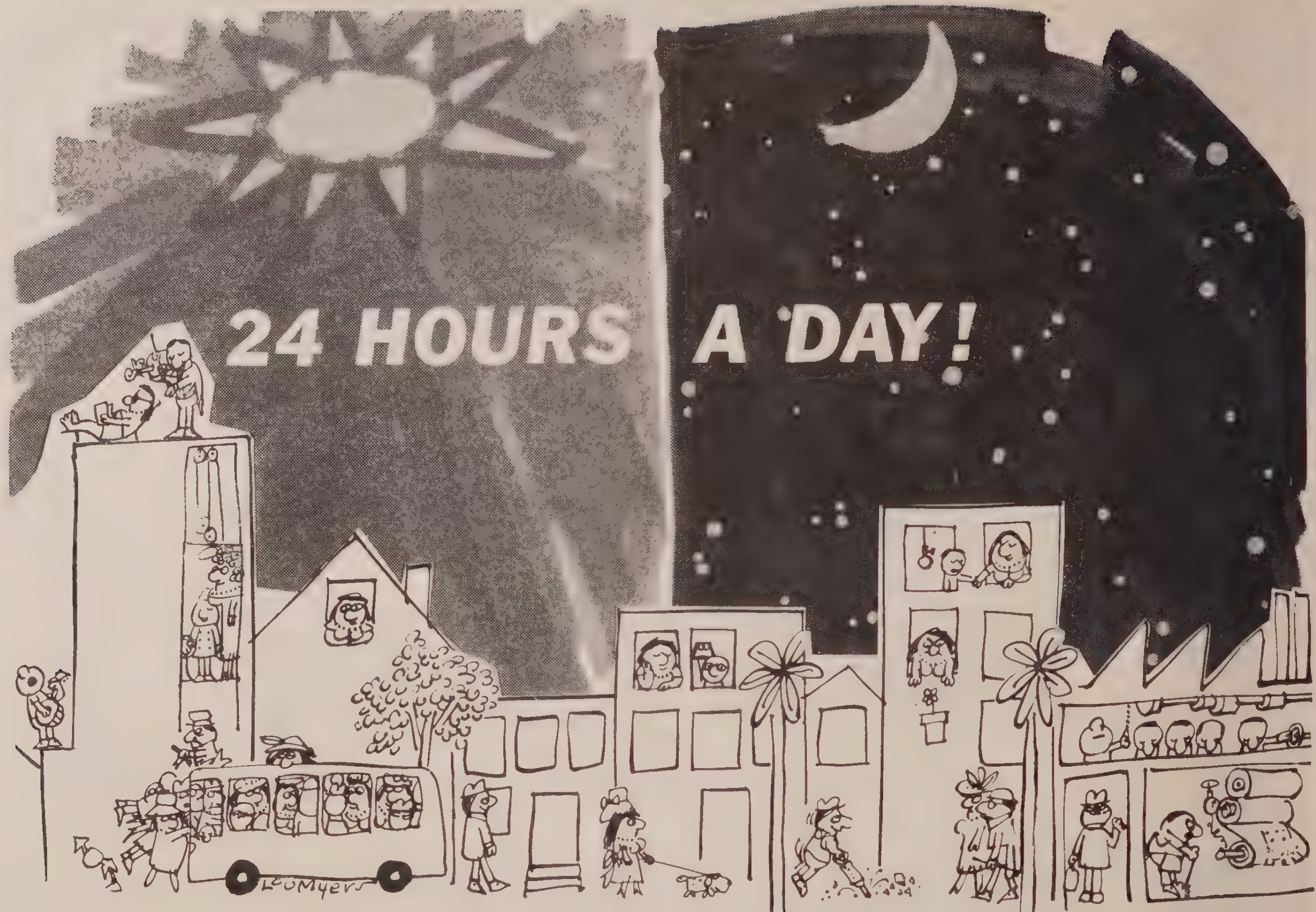
Meters on display include: extended range watthour meters, appliance meters, thermal demand meters, polyphase meters and the newest socket-type mounting devices. A 1912, five-amp, two-wire, 120 v a-c watthour meter has been included to show the improvements made in metering during the last 50 years.

Over 20,000 miles have been logged by the unit and 1,000 men have already seen the demonstration. A schedule for national coverage is being coordinated in Duncan's Lafayette, Indiana, headquarters.

By taking the meters to the men in each small shop it is hoped that they will be kept up-to-date on the newest changes that are taking place in metering.

After cabinets are placed into position, their doors are opened or removed. At this point, the exhibit is completely set-up and ready for showing—the entire operation taking less than ten minutes.

Some of the materials involved in recent court controversy between Preformed Line Products Co. and The Fanner Mfg. Co. are examined by Fanner's Joseph L. Bisesi, research engineer, and Seymour Schlein, factory manager. U. S. District Court ruled (see EL&P Feb. 1, p. 8) that Preformed's dead end patent is valid and has been infringed by Fanner, but denied any damages or injunction to Preformed; but found Preformed's "short pitch" armor rod patent invalid and not infringed by Fanner. The Court's Opinion noted that Preformed "is the largest manufacturer and seller in the U. S. of helically preformed reinforcements and attachments for use in electrical cables and is unquestionably the dominant company in this specialized field, its only competitors being its two licensees. The dead ends covered by Patent No. 4 have gained wide acceptance in the electrical industry. Due to the constantly growing demand for such devices, jobbers and distributors of armor rods are required as a matter of good business to carry preformed dead ends in stock. The infinite possibilities for public and private harm inherent in plaintiff's continued misuse of its patent monopoly can be abated only by a denial of relief to plaintiff in this action . . . until plaintiff . . . has wholly abandoned its improper practices."



ROEBLING GAS-FILLED CABLE!
looks out for your best interests!

Roebling Gas-Filled Cable (for voltages up to 46 kv) is *self-supervisory!* Super-dry nitrogen gas, inside this cable at approximately 12 p.s.i. pressure, is the key. When gas pressure drops below 10 p.s.i. or rises above 16 p.s.i.—an automatic signal message is relayed to the nearest attended station. You know when trouble's afoot the second it starts! Repairs can be made *before* serious damage occurs!

Along with this extra *protection,* this cable has properties that lessen the possibility of outages! The inert dry nitrogen gas provides consistent dielectric properties throughout the length of the cable. It prevents ionization, too, and the other problems often associated with solid-type oil-impregnated cable. What's more, it's as easy to splice as solid-type! And if your system includes grades, it may prove to be the most inexpensive cable you've ever used!

Our new Gas-Filled Cable book tells more about this superbly-made cable. It's free—write for it. Roebling's Electrical Wire Division, Trenton 2, New Jersey.

ROEBLING

Branch Offices in Principal Cities
John A. Roebling's Sons Division, The Colorado Fuel and Iron Corporation

Westinghouse To Give $3-Million Push To Total Electric Home Drive

"We're convinced that the future of the Total Electric Home is assured," said Chris J. Witting, Westinghouse vice president, as he announced the kickoff of the 1960 Total Electric Home promotion campaign.

CHRIS J. WITTING, Westinghouse vice president, announced that the company will spend $3-million for promotion of the Total Electric Home in 1960. A portion of the program involves detailed house plans custom designed for electric living. A few of the 16 models are shown behind Mr. Witting.

And to back up their conviction, Westinghouse has pledged $3-million for promotion of the program during the coming year.

As the keystone to their efforts, Westinghouse has had 16 homes designed by five different architects in five different climatic regions. The houses, specifically designed for electric living, fall within different catagories price-wise, size-wise, and purpose-wise. Model homes built from the Westinghouse plans will be constructed in key markets across the country.

Mr. Witting and William H. Loeber, manager of the Total Electric Home department reviewed accomplishments during 1959 to indicate the program's market potential. Pilot marketing programs involving model homes were conducted in seven different cities in different sections of the country. Within two weeks of the initial opening of these models last year, more than $1-million worth of Total Electric Homes were sold.

According to marketing analysts at Westinghouse, there are about 600,000 electrically heated homes in the U. S. today. By the end of 1960, this number is expected to rise to 700,000. By the end of 1970, it should total 2.2 million homes.

In addition to providing the plans for its houses to builders and the public at nominal cost, Westinghouse expects to divert a large percentage of their advertising budget to the Total Electric Home program. Westinghouse will again sponsor both political conventions and one-fourth of the commercial time of each will be devoted to the Total Electric Home drive. The company is also entering into a huge cooperative advertising effort with utilities and builders.

While the Total Electric Home program has been in operation for only one year, it is already receiving the cooperation and active support of 85 electric utilities in the United States. EEI has adopted the project name and combined it to promote the "Total Electric Gold Medallion Home" during the coming year.

Predict Company-Owned Auto Fleets On Way Out

The company-owned automobile fleet will virtually disappear during the 1960's and will be replaced by the leased fleet, according to a prediction by A. J. Schoen, president of one of the nation's leading leasing agencies.

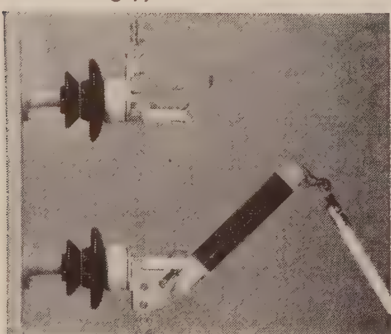
Speaking to the annual convention of the American Automotive Leasing Association, Mr. Schoen reported that in the past decade, leased fleets for salesmen have become the main form of transportation in 10 major industries. He emphasized that leased auto fleets now outnumber company-owned fleets in all industries combined.

LOW-COST SWITCHING

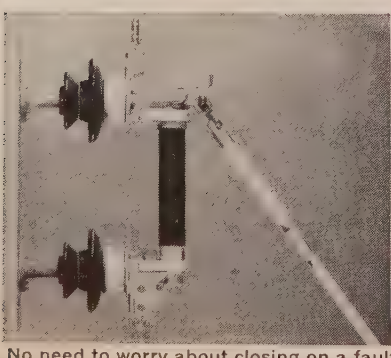
HOW THE SM-4 SWITCHES

Photo at right shows the fuse being opened with Loadbuster. Photos below show closing sequence with conventional handling tool.

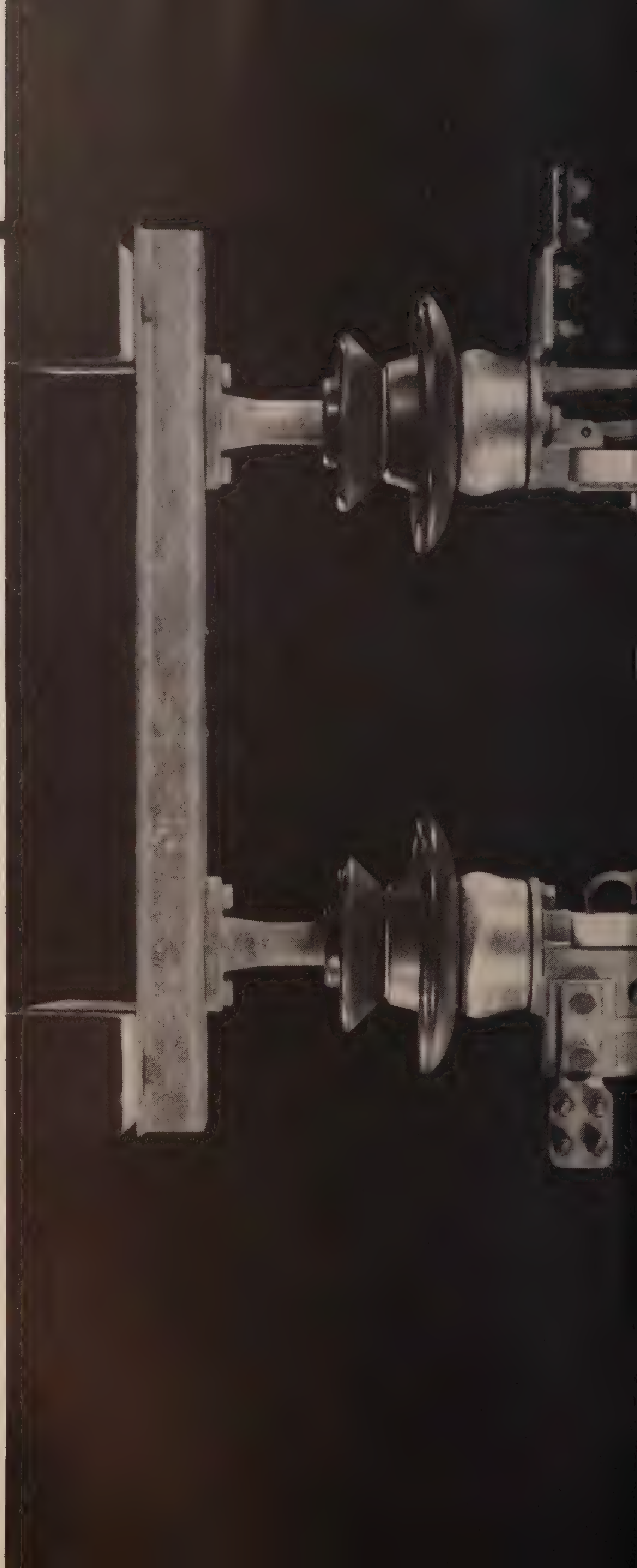
Hang fuse holder in hinge. (Note disconnect gap) . . .



Swing holder closed . . .



No need to worry about closing on a fault —the SM-4, a boric acid fuse, interrupts effortlessly.



Now even power fuses operate with S&C's Loadbuster® — no need to add a disconnect

That's right . . . no disconnect required! If it's S&C's outdoor SM-4 Power Fuse, you switch with the fuse itself—plus Loadbuster.

On transformer primaries there's no separate investment in disconnects for energizing, or for de-energizing and isolating. For line sectionalizing the same holds true—and then some! With Loadbuster it's possible to drop the line, split the load, even dump the load—up to 14.4 kv.

Here's how it works. The SM-4 Power Fuse is equipped with an attachment hook to accommodate Loadbuster. Just hook Loadbuster onto this hook and into the pull ring, pull fuse open and the circuit is interrupted. Result: full load switching at full voltage with no arcing, no contact burning. In one device you get full switching and isolation as well as fault protection.

The key to the Loadbuster system of universal, low cost load switching? Portability! . . . bringing the interrupting device to the power fuse, disconnect, or cutout only when it's needed. In this way the cost of Loadbuster is spread over all the fuses, disconnects, and cutouts on the distribution system.

For more information contact S&C Electric Company, 4435 Ravenswood Avenue, Chicago 40, Ill. We will be glad to give you a demonstration of how Loadbuster works.

S&C ELECTRIC COMPANY

NEW PRODUCT DESIGN

Fully Transistorized Data Processing System

The large-scale IBM 7080 data processing system can produce utility management reports and process payrolls, inventory control, billing and similar accounting jobs up to ten times faster and at substantially lower job costs than possible on the IBM 705. The equipment can make 303,000 logical decisions a second and in the same time can read or write 312,500 characters of information. In one second it can also add or subtract 78,000 six-digit numbers or multiply 7,100 six-digit numbers. The 7080 is designed to accept 705 I and II programs and process them more than six times faster. The solid state 7080 needs only 50 per cent of the air conditioning and power of its predecessors and 30 per cent of the space. It may be combined with appropriate off-line elements of the 1401 data processing system such as punching, printing, and card-to-tape conversion.

Circle item #20 on reply card.

Reduce Regulator Size

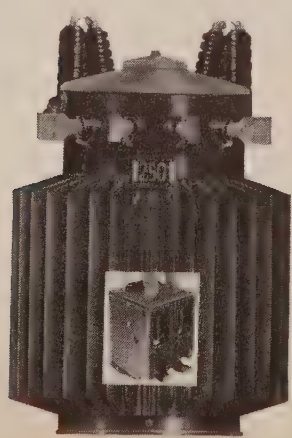
Single-phase, 5/8-percent regulator line, the JFR by **Allis-Chalmers Mfg. Co.,** has been redesigned to be 40-percent lighter with height reduced up to 30 percent. Reduced weight comes from new wound-core design, preventive autotransformer, potential and current transformers, and rearrangement of internal connections for better space factor. Redesigned position indicator with electrically-reset drag hands, adds to the operating convenience.

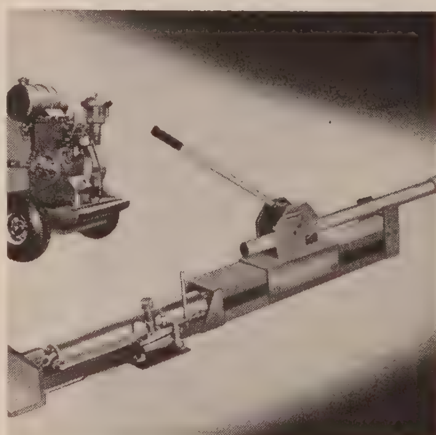
Circle item #23 on reply card.

Electric CSP Breakers

Electrically-operated circuit breaker (type ER) by **Westinghouse Electric Corp.,** extends the company's line of CSP transformers up through 250 kva, 240/480 v. It protects against burnouts from secondary faults and gives warning of dangerous overloads by a signal light arrangement similar to the method used in previous designs. The ER is capable of interrupting 23,000 amps at 240 v. The mechanism trips and recloses automatically.

Circle item #21 on reply card.





Redesign Pipe Pushers

Fully-powered "Speed-Thru" pipe pushers, by **Mercury Hydraulics, Inc.,** now incorporate a higher-speed, 12-in. stroke design, pushing one ft in 11 seconds. In three sizes, the pushers can grip 2-, 3-, or 4-in. ID pipe, and with thrusts up to 110,000 lbs. They can be installed in an operating trench as short as 52 in. Other features include a non-crushing, self-gripping and releasing pipe clevis, and wider trackage for the thrust carriage wheels.

Circle item #22 on reply card.

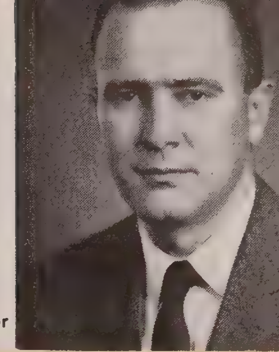
Two-Way Personal Radio

Two-way personal radio communications system by **Seiscor Div. of Seismograph Service Corp.,** is light weight and completely portable. It is a limited-range system for person-to-person communication, utilizing a completely transistorized transmitter-receiver unit weighing less than one pound, including batteries. It is about twice the size of a king-size cigarette package, including batteries, in the belt-pack model. Five models available.

Circle item #24 on reply card.

from Sangamo Electric:

An interim report to the Electric Utility Industry on your response to our question . . .



GLENN M. DeKRAKER
Assistant Marketing Manager

Why Call it Demand?

Does the word "demand" make you bristle?

While we all know that demand charges are fully justified from the standpoint of basic economics, the electric power customer often fails to realize that it is he who is making demands on the utility rather than the other way around. If psychology has a place in rate-making, should the word "demand" have ever been admitted to the electric utility vocabulary?

Electric customers, tabbed with a *demand* charge on their electric bills, have a tendency to bristle at the term.

If we remove *d*
metering, it be
concept . . . an
and less offe
as load, ne

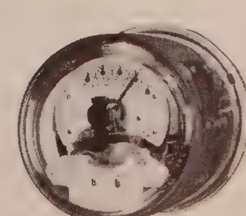
Recently, in an advertisement, we questioned the use of the word "demand" applied to the measurement of power usage. The point was made that it is time for all of us to reconsider our use of the word, and asked for your opinions and suggestions about what to do with this thorn-in-the-side term.

Many of you have taken time to write us. We've heard from utilities, editors, and manufacturers throughout this country, Canada and South America. Some of you went to great lengths to express your preferences for a new term. Most all of you who wrote agreed with us . . . it's time to take the "demand" out of demand metering and substitute some term that is less offensive and more easily understood.

So far, you've suggested 43 different words or terms which you believe will do a better public relations job than "demand." "Capacity" is the word you mentioned most often, followed by "load peak" and "load," then by "maximum load," "use," and "capacity charge." Suggestions are still coming in.

If you haven't already written us as to your suggestion, we would like to hear from you.

Regardless of what you call "demand" measurement, you can depend on Sangamo Meters to do it better.



Sangamo offers the most complete line of demand* measuring instruments in the industry . . . equipment to indicate and record demands from the smallest values to the largest encountered by the electric power industry. The line includes singlephase and polyphase Type D mechanical demand registers, Lincoln indicating and graphic demand meters, digital demand recorders and translating systems for Kw, Kvar, and Kva demand. You can look to Sangamo for all types of demand measurement.

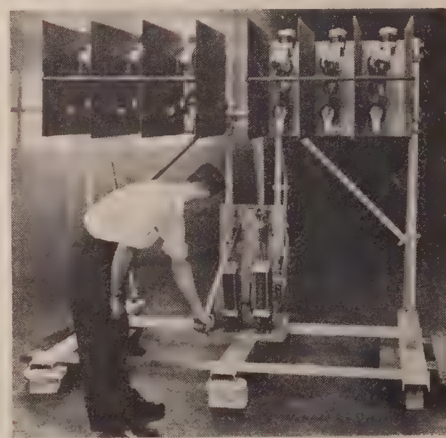
*Until all the returns are in, and you've selected a new term.

SANGAMO ELECTRIC COMPANY, Springfield, Ill.

Switch Transfer Mechanism

Delta-Star Electric has developed a dual cylinder, double throw automatic switch transfer mechanism activated by stored energy for use where extended service interruption could be disastrous. Timing device allows 0-30 second delay for circuit breakers to operate properly before triggering preferred cylinder. The switches are equipped with Powerrupters and have insulating barriers between the phases.

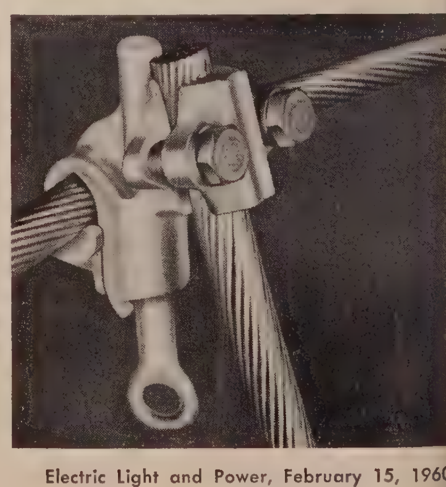
For more data, mark #25 on reply card



All-Aluminum Tap Clamp

A tap clamp of all aluminum construction which accommodates main line and jumper wire up to 397.5 MCM ACSR has been marketed by **A. B. Chance Co.** Specially designed for use in marine or industrial areas where corrosive problems are severe. Extra wide clamp jaws make maximum contact with the outside strands of the main line conductor. A special "waved" main line contact shape assures making low resistance contacts.

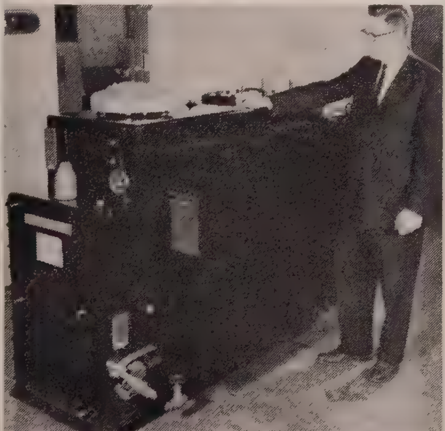
For more data, mark #26 on reply card



Traffic Cone Flasher

Easy to place and put into action is the **R. E. Dietz** No. 630 Visi-Flash transistorized warning light. Produces approximately six beam candlepower through a plastic 360-degree red or amber lens and has a signal duration strength of 400 hours. The flash lasts 1/10 sec. and pulsates 65 times per minute. Utilizes four "D" cells and is loaded in the same manner as a flashlight. On-off operation is controlled by the battery case cap.

For more data, mark #27 on reply card



Universal Network Transformer

Ratings of 300, 500, 750 and 1000 kva at 5, 15, 25 and 34.5 kv are available in a universal network transformer designed for either vault or subway applications. By **Westinghouse,** the unit replaces two separate models offered previously. The transformer has 30 per cent fewer welds and improved corrosive protection of welds due to better film thickness of paint. Retains advantages of Space-Miser line.

For more data, mark #28 on reply card

HOW SOUTHERN STATES' BV-33-F CUTOUT CLEARS RESTRICTED OR HIGH FAULTS WITH EQUAL DEPENDABILITY

The complexities of today's distribution systems present a real challenge to the designers of cutouts. Industry requirements call for interrupting capacities up to three times higher than a few years ago. And yet the cutout must clear restricted faults with equal ease and sureness.

Large bore tubes, vented freely at both ends, will clear extremely high faults easily. Small bore tubes, vented at one end, will clear low faults easily. The big problem is to do both.

The Southern States BV-33-F Heavy Duty Cutout clears the complete range of fault currents with equal dependability—without damage to the cutout.

What About Single-Venting?

In single vented cutouts, the rocket effect of the tube, as gases are ejected, must be considered. Some type of shock absorber to cushion the fuse holder, as it tends to thrust upward, must be provided. But so far no practical recoil mechanism has been devised that can fully absorb the violent recoil action. Thus a substantial amount of shock is transmitted to the mounting, insulator, bracket, and cross arm.

As interrupting capacities on single-vented cutouts are increased, bore diameters become critical. If it is large enough to handle high faults, it may provide only borderline protection on restricted faults. Resorting to some extraneous means, such as special types of fuse links, is a dangerous concession to security—as there is no assurance of proper fusing in the field.

What About Controlled Venting?

Providing a small vent hole in the top hardware to permit a limited amount of gas to escape is not the solution either. This practice was dropped by Southern States long ago, when it was found that the hole became enlarged after each operation, endangering proper clearance of low faults.

Here's the Answer

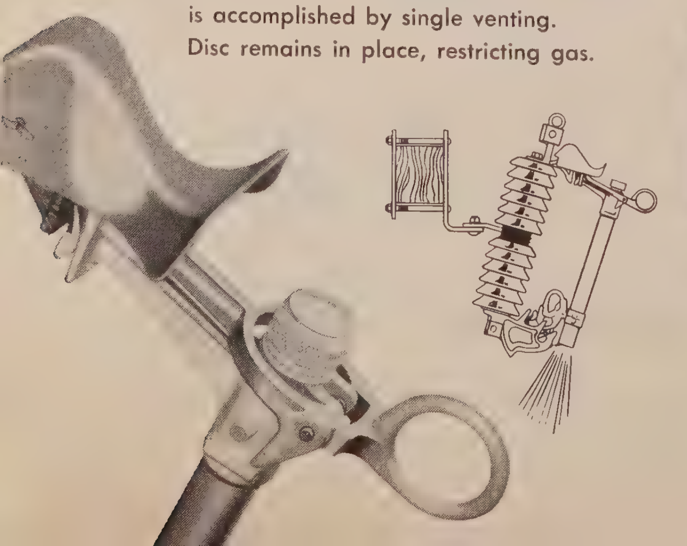
The BV-33-F offers all of the advantages and none of the disadvantages of single-venting or controlled-venting. This is accomplished with an economical expendable cap which confines gases on restricted faults, but allows them to double vent on high faults. Forces inside the tube are equal and opposite. Stress on the mounting is virtually eliminated. The cutout can operate time and time again without loss of efficiency. There is no built-in battering ram—no intricate mechanism, or springs to worry about. And any standard EEI-NEMA fuse link will provide positive operation every time.

Utilities throughout the nation are finding the BV-33-F a practical, workable solution to cutout problems.

Get complete information from your Southern States representative, or write for Bulletin 580C.

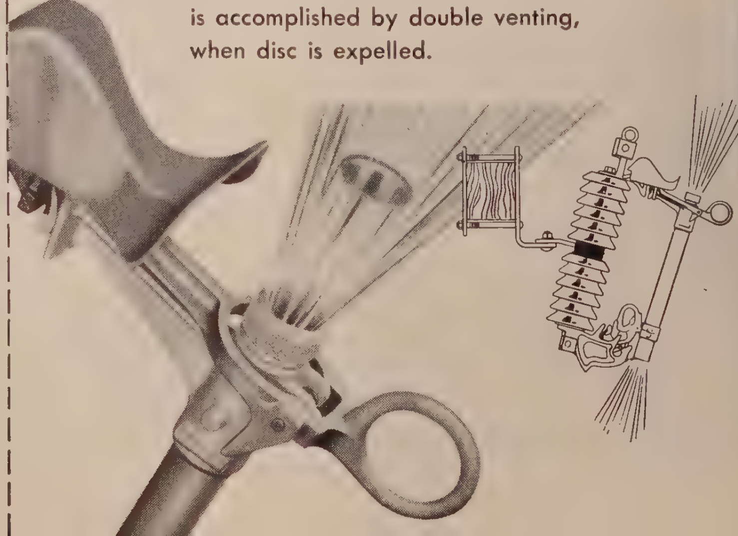
LOW FAULT CLEARANCE

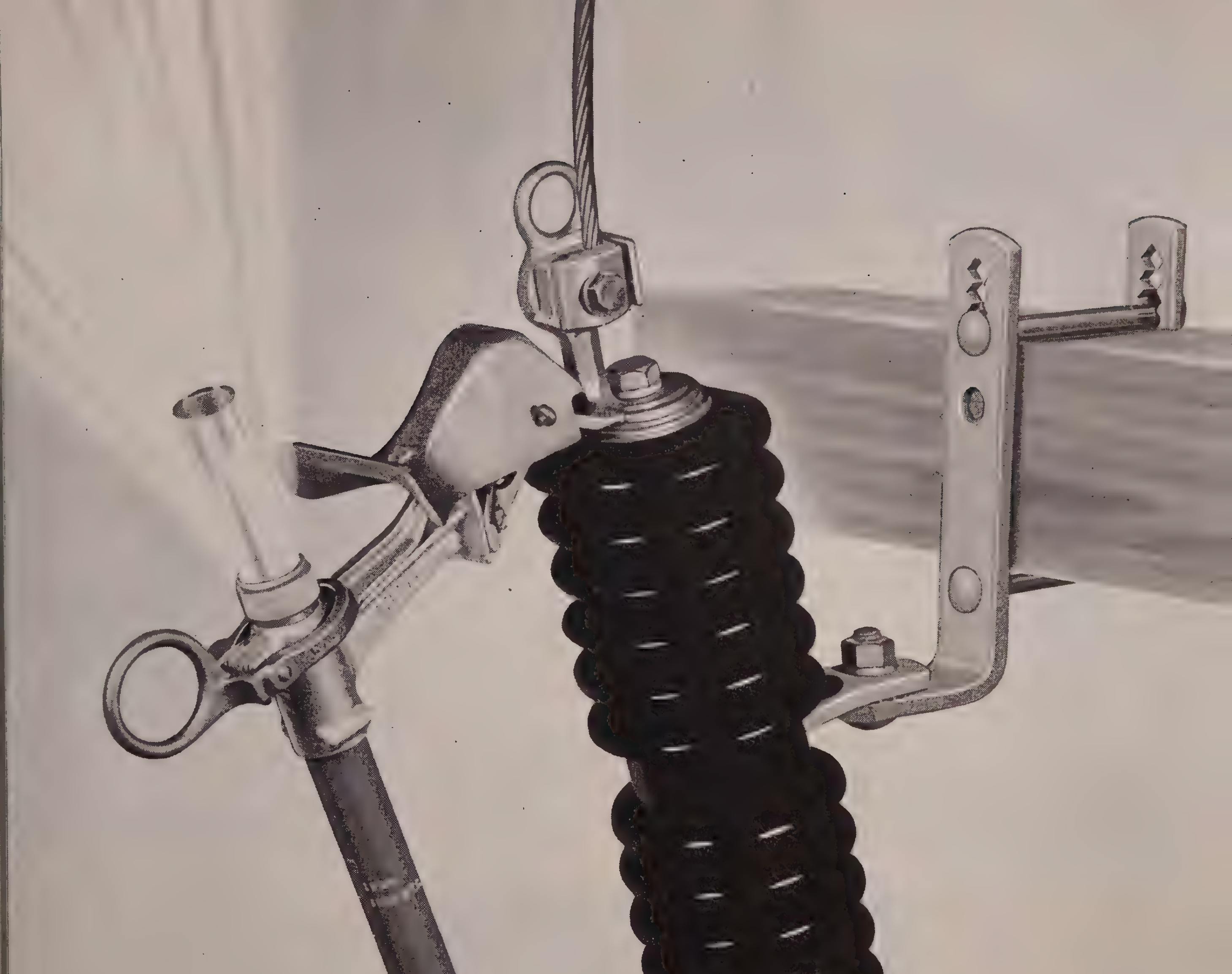
is accomplished by single venting.
Disc remains in place, restricting gas.



HIGH FAULT CLEARANCE

is accomplished by double venting,
when disc is expelled.

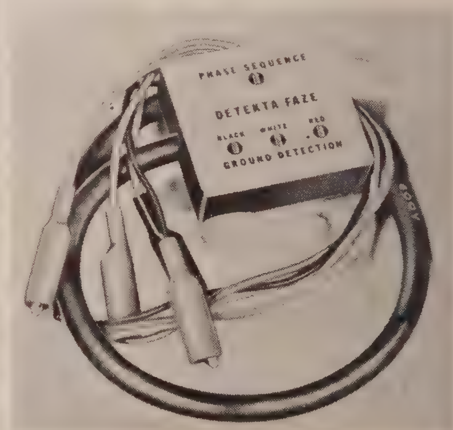



KEEP PACE ELECTRICALLY

Phase and Fault Indicator

Detekta-Faze by **Glo-Lite Instrument Co.** allows predetermination of direction of rotation for any motor without starting equipment, thus avoiding costly errors and possible injury. Has no switches, no moving parts and no batteries. Only slightly larger than a package of cigarettes, the instrument has but one indicating light. The unit may be used on two- or three-phase systems, within an operating range of 200-v to 500-v, 60 cycle a-c.

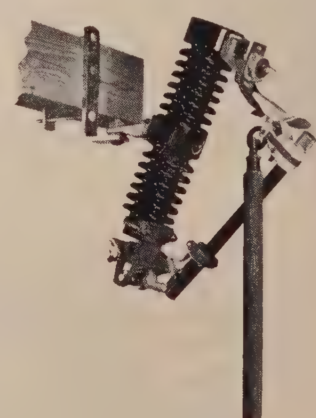
For more data, mark #29 on reply card



Load Break for Open Cutouts

A gas load break device that provides more efficient load-switching for open dropout fuse cutouts has been introduced by **General Electric.** A small replaceable gas-filled monel cylinder positioned in the fuseholder's upper contact converts each open type cutout to a load break switch. Device has been incorporated into G-E's line of open dropout cutouts, available in both 7.8- and 15-kv heavy and extra heavy duty fuseholders.

For more data, mark #30 on reply card



Politics . . . *(Cont'd from p. 63)*
ployees *may* attend but only on a voluntary basis. The group meetings are *for* and are conducted *by* non-management employees and no attempt is made to brainwash employees into thinking as the company would like them to think. The goal is effective personal thought, with understanding of the issues and probable effects involved.

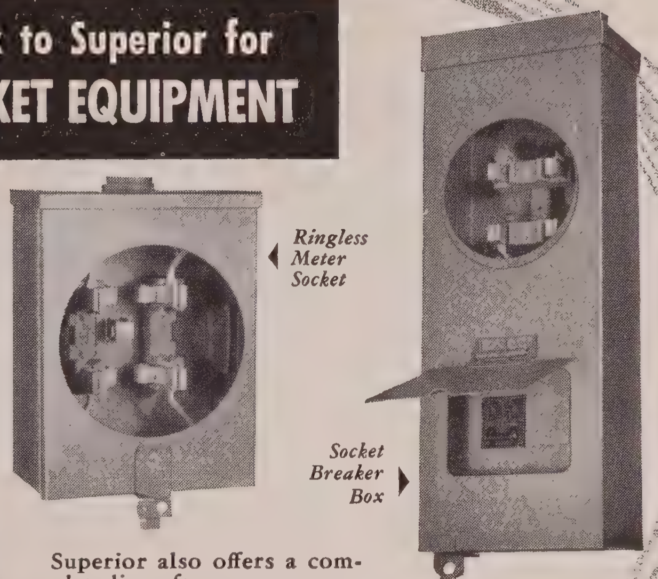
Many may ask if this is really business getting into politics. While long range in scope, exceedingly slow, and with no measurable guaranteed results, such a program *is* political participation.

A recent National Industrial Conference Board meeting on the subject of company participation in the political arena devoted a full day to an investigation of the subject and could come up with only one basic agreement—that only an education program is completely free of government intervention or regulation and relatively sure of success. The panel posed several guides to setting up a program:

1. Decide what the goal really is.
2. Proceed slowly and carefully.
3. Do not dictate company policy to participants as the gospel truth.
4. Encourage outside participation by employees in party activities, regardless of the party they endorse.
5. Provide education, not propaganda.
6. Be patient; the goals are long range.

A program like Detroit Edison's is to be highly recommended. If utility companies can stimulate political awareness and encourage active participation of its employees in political activities, regardless of party, it is a better bet that the life of the industry will be insured.

Indeed, the support of utility employees can hardly be overestimated. As one of the recognized authorities in the industry, Middle West Service Company's R. M. Winsborough, says: "If our employees are informed and are aggressive, they can do more to improve public relations than any other force at our command. In the particular field of exerting political influence, the employees are our most effective channel of action. For that reason, we should start informing our employees first."



New Electrical Lab Helps T&D at Joslyn

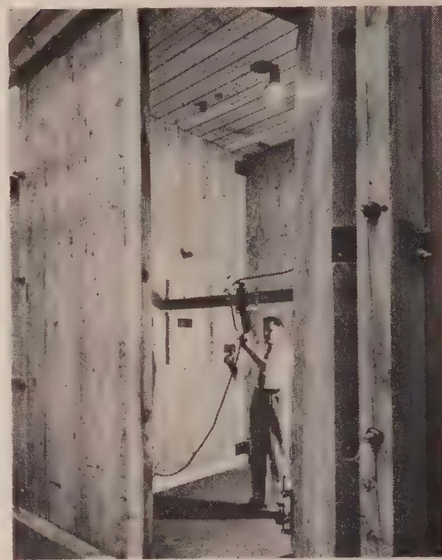
Test and Development at Joslyn's new electrical lab benefit from a highly engineered mix of equipment—some new enough to be unique—some old enough to have historical importance—some conventionally commercial—all arranged for effective use.

The company-engineered impulse generator shown above is unique in its several capabilities. As pictured, it delivers standard impulse waves up to 1800-kv for testing insulator strings, crossarms, etc. Folded, so as to parallel its capacitor banks, it can achieve (at 600-kv) a current rise as fast as 40,000-amps per microsecond. It can also produce low current (300-amp), long duration (3000-microseconds) surges as required for testing valve type arresters.

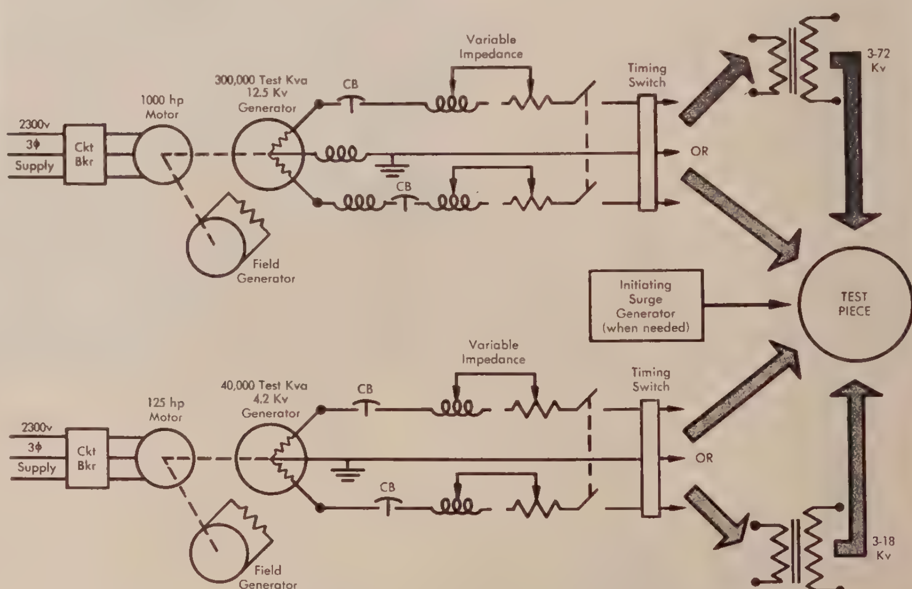
The diagram below shows how the high current output of a 300,000 short circuit kva generator or a 40,000 short circuit kva generator may be focussed on equipment under test. Special low reactance transformers provide any system voltage to 72-kv. The precise time at which fault current is to begin is achieved with a high speed switch.

The surge generator shown in the diagram performs two functions. On lightning arresters it permits discharge current withstand tests up to 125,000 amps. In addition, it is often used to initiate the fault for power follow tests.

Fragmentation of an arrester or cutout under destructive test is confined by the 6x8 inch timbers of the test cell shown. High speed pictures may be taken through bullet-proof windows. Closed circuit television allows observation with even greater safety.



The new lab addition is a refinement and extension of a program already proven for a dozen years. It should hasten the development of new Joslyn circuit-interrupting devices. In addition it promises production-line testing techniques for still greater reliability of existing equipment.



Anaconda To Construct Research Center

Plans to construct a $1.5-million research center for the American Brass Co., a wholly-owned subsidiary of the Anaconda Co., have been announced. According to Richard M. Stewart, president of American Brass, ground will be broken this summer, with completion scheduled for 1961.

The company's research center will include metallurgical, corrosion, and chemical laboratories, and equipment for experimental production of new products.

Nuclear Electronics Enters FM Multiplex Field

Nuclear Electronics Corp. has acquired the Electro-Plex Corp., a pioneer in the FM multiplex field. The acquisition will operate as a separate division of Nuclear Elec-

tronics, and will move its equipment and personnel to the Nuclear headquarters in Philadelphia in the near future.

Alcoa Installs Nation's Largest Extrusion Press

A 14,000-ton extrusion press—installed side by side with its twin, the largest such unit in the nation—is now in production at Alcoa's Lafayette, Ind., works. The unit is capable of extruding single pieces of aluminum in widths up to 39 in. and weighing up to 2,500 lbs and makes possible formation of seamless pipe and duct with 20-in. outside diameter and up.

Sales Briefs

Jack H. Stumph, 1000 Fourth Ave., South, Seattle, Washington, has been appointed underfloor duct representative in Oregon, Washington, Montana and northern Idaho for **The National Supply Company.** He has been conduit representative for the company in that same area for several years and will also continue in that capacity.

Seabrook Machinery Inc., Tallahassee, Fla., and Albany, Ga., has added HYDROCRANE machines to the line of excavating and crane equipment that it distributes for **Bucyrus-Erie Co.,** in north central Florida and southwestern Georgia. The firm now offers sales and service on the full line of Bucyrus-Erie equipment.

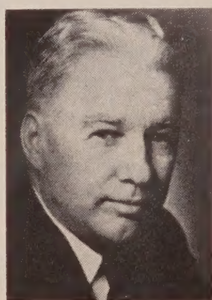
McCabe Powers Body Company, 1461 East Washington Boulevard, Los Angeles, California, has been appointed a stocking distributor for **Pacific Mercury** flasher warning lights and electric plants.

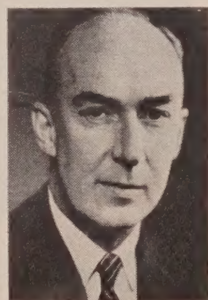
Dage Television Division of Thompson Ramo Wooldridge Inc., has appointed **Hoffman Sales Corporation of California**—a wholly-owned subsidiary of Hoffman Electronics Corporation—direct factory distributor for its complete line of closed circuit television equipment.

MEN OF  POWER

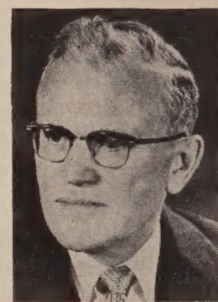
Stone & Webster Announce Top Management Changes

Stone & Webster Engineering Corp. has announced the election of T. Cortland Williams, president since 1955, as chairman of the board. Fred W. Argue, executive vice president, was elected president to succeed Mr. Williams in a series of top management changes.


Williams


Argue


Hartridge


Good

Other management changes made include the election of Alfred L. Hartridge, financial vice president, as executive vice president, and of Dr. Arthur J. Good, vice president and comptroller, as vice president and treasurer.

Mr. Williams has been with Stone & Webster since 1923. During the past 26 years he has directed the construction of many different projects, including the AEC installation at Oak Ridge, Tenn.

Mr. Argue joined the firm in 1941 as a power engineer, after 20 years experience in the utility field. He was elected executive vice president in 1959, after serving as engineering manager since 1954.

A 29 year veteran of the Stone & Webster organization, Mr. Hartridge was made treasurer in 1953 after field experience and service in the New York and Boston offices. He was named vice president in 1954.

Dr. Good was appointed comptroller of the company in 1956 after five years as managing director of the company's London office.

Two VP's Elected by United Illuminating

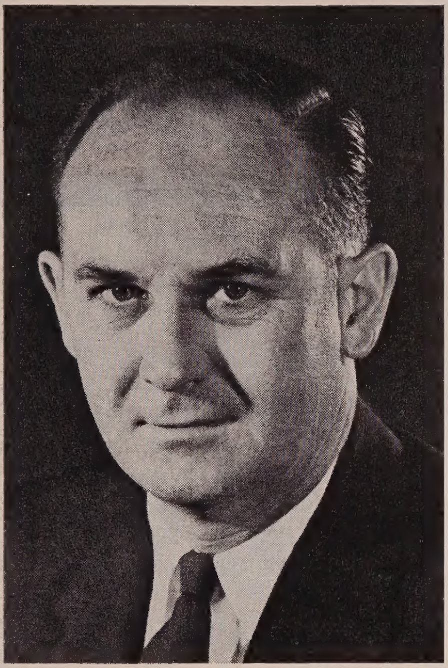
The election of Marshall F. Beebe and Edward H. Walton as vice presidents of The United Illuminating Company has been announced by William J. Cooper, company president.

Mr. Beebe, general superintendent of UI since 1950, will continue to be responsible for the company's production, transmission and distribution of electric power. Mr. Walton, manager of engineering and construction since 1953, will continue to be responsible for those operations of the company.

With UI for 43 years, Mr. Beebe started as an office boy and served as field engineer, supervisor of overhead lines, superintendent of distribution in the company's New Haven Division, general superintendent of production and superintendent of operations.

Mr. Walton who joined UI in 1942 as a mechanical engineer, received a bachelor of science degree in civil engineering at Swarthmore College. He also has served as assistant superintendent of production, assistant to the president and assistant general superintendent of the company.

Bonner PG&E VP



John F. Bonner has been elected vice president of the Pacific Gas & Electric Co. He will be in charge of engineering, and succeeds Walter Dreyer, who is retiring after 43 years with the company.

A civil engineer, Mr. Bonner has been assistant to Mr. Dreyer since 1955. Throughout his work life at PG&E, he has been connected with hydroelectric engineering. He first joined the company as an assistant hydrographer in 1937, immediately upon graduation from the University of California.

Mr. Dreyer, who joined the company on a full time basis in 1916 will be retained as a consultant on pending major projects.

PP&L Elects Financial VP

Pennsylvania Power and Light Co. has announced the election of F. H. Markley to the post of vice president, financial. He succeeds A. D. Root, who has retired.

Mr. Markley is a 35-year veteran of PP&L. He was named treasurer in March, 1952, and served in that capacity until being named assistant vice president, financial, in October, 1957.

Mr. Root has been with PP&L since 1945, following 26 years with Ebasco. During his 15-year tenure as chief financial officer, he guided the PP&L financial operations through its most active period of expansion and modernization.

Men Of Power Briefs

Edward A. Rudulph has been appointed manager of Union Electric's new pumped storage project. He was formerly superintendent of production engineering.

Elmer B. Hurst, assistant personnel director of the Virginia Electric and Power Co. has been made safety director for the company.

Joe H. Box has been named director of area development for the Mississippi Power and Light Co., while **C. Lamar Stephenson, Jr.,** has been appointed division manager for the western division.

AIEE has appointed **Ivan S. Coggeshall** manager of technical operations services.

Combustion Engineering, Inc., has appointed **Francis A. Schroff** manager of corporate purchasing. He was formerly in charge of purchasing for the New York division.

Dr. Robert C. Langford, a leading authority on instrumentation, has been named director of engineering of the Newark operation of Weston Instruments division of Daystrom, Inc. He succeeds **Francis X. Lamb.**

CALENDAR OF EVENTS

February 18-19—American Institute of Electrical Engineers, Engineering Aspects of Magnetohydrodynamics Conference, University of Pennsylvania, Philadelphia, Pa.

March 6-9—American Society of Mechanical Engineers, Fifth Gas Turbine Conference, Hotel Rice, Houston, Tex.

March 14-18—National Association of Corrosion Engineers, 16th Annual Conference and 1960 Corrosion Show, Dallas, Tex.

March 21-23—Southeastern Electric Exchange, Annual Conference, Boca Raton Hotel, Boca Raton, Fla.

March 21-23—National Electrical Manufacturers Association, First National Electric House Heating Exposition, Hotel Sherman, Chicago, Ill.

March 24-25—Oklahoma Utilities Association, Annual Convention, Oklahoma Biltmore Hotel, Oklahoma City, Okla.

March 27-29—Southwest Electric Conference, Chandler, Ariz.

March 28-29—Pacific Coast Electric Association, Engineering and Operation Conference, San Francisco, Cal.

March 29-31—22nd Annual American Power Conference, Hotel Sherman, Chicago, Ill.

April 3-8—Engineers Joint Council, Nuclear Congress, Coliseum, New York, N. Y.

April 7-8—Southeastern Electric Exchange, Engineering and Operation Section Conference, Roosevelt Hotel, New Orleans, La.

April 11-13—A. and M. College of Texas, Thirteenth Annual Conference for Protective Relay Engineers, College Station, Tex.

April 20-22—Missouri Valley Electric Association, Engineering Conference, President Hotel, Kansas City, Mo.

April 27-29—Northwest Electric Light and Power Association, Engineering Conference, Hotel Florence, Missoula, Mont.

April 28-29—Pennsylvania Electric Association, Systems Operation Committee, Bedford Springs Hotel, Bedford, Pa.

May 2-4—Edison Electric Institute, Purchasing and Stores Committee, Annual Meeting, The Warwick, Philadelphia, Pa.

May 16-18—Pacific Coast Electrical Association, Annual Convention, Stardust Hotel, Las Vegas, Nev.

May 23-25 — Northwest Electric Light and Power Association, Business Development Conference, Chinook Hotel, Yakima, Wash.

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